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(BAW—10074A(Rev.1))
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Volume 4, Number 20, October 31, 1979

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

49430 (SAND—79-8655) **Research efforts in eight industrial countries to increase the use of coal.** Pohl, J.H.; Hardesty, D.R. (Sandia Labs., Livermore, CA (USA)). Jun 1979. Contract EY-76-C-04-0789. 38p. (CONF-791001—1). P 03/MF A01.

From United Nations symposium on world coal production; Katowice, Poland (Oct 1979).

During 1977 and 1978 we visited with, discussed coal research with, and reviewed the technical literature of coal research institutes in eight countries, Australia, Federal Republic of Germany, France, Netherlands, New Zealand, Polish People's Republic, United Kingdom, and the United States. We were able to visit utility companies, boiler manufacturers, private research laboratories, government research laboratories, and universities in these countries. Coal is the only fuel other than nuclear power that can satisfy the short term energy needs of the world. Coal resources are adequate to fulfill these energy needs. In the future, as now, most of the coal used will be burned as pulverized coal in large industrial and utility boilers. However, two major problems must be addressed before use of coal can drastically increase. First pollutant emissions from coal-fired boilers must be controlled at levels acceptable to the populace and at costs acceptable to the utility operators. Second, improving the precision with which boilers are designed and the availability of the boiler during operation can improve the competitivity advantage of coal over other fuels. When these problems have been solved, world coal use should increase in proportion to coal resources. (LTN)

PROCESSING

CARBONIZATION

49431 (COO—4553-1) **Dry coke quenching study. Final report, September 1978.** (National Steel Corp., Pittsburgh, PA (USA)). Sep 1978. Contract EC-77-C-02-4553. 27p. P 03/MF A01.

The financial evaluation of capital and operating cost estimates for a dry coke quenching facility installation indicates a marginal return on investment if the evaluation is based exclusively on steam credits. However, the potential improvements in environmental emissions and reported, but unverified, blast furnace operations may justify the expenditure. The Russian and Japanese claim of 2 to 4% reduction in blast furnace coke usage with up to 4% increase in iron production has not been demonstrated in the domestic steel industry and, therefore, is not included in the financial analysis. A 2% coke reduction represents a savings of approximately $0.81 per ton of hot metal produced or an additional annual credit of $1,800,000 for dry coke quenching, exclusive of productivity gains. Additional credit of this magnitude would increase the estimated discounted cash flow return from 10% to approximately 16% for the estimated capital expenditure of $21,742,652. The projected world escalation in fuel cost, National conservation goals, possible energy supply shortages, and environmental considerations in conjunction with the need for a full scale, controlled test of dry quenched coke in a dedicated blast furnace are decisive factors in considering the merits of this proposal. National Steel Corporation is prepared to cooperate in the development and implementation of this program.

49432 (FE—1220-39(Vol.2)) **Clean coke process: process development studies. Final report. Volume II: summary of PDU studies.** (USS Engineers and Consultants, Inc., Pittsburgh, PA (USA)). Nov 1978. Contract EX-76-C-01-1220. 170p. P 08/MF A01.

The PDU program included studies on carbonization and hydrogenation of coal and production of a pelletized formcoke from process char and binders based on SRC-I product. Carbonization procedures generally entailed preoxidation at 350 to 400°F to reduce agglomeration characteristics, followed by two stages of carbonization, at 820 and 1400°F, and at a pressure of 165 psia. For the Pittsburgh coal, preoxidation and first-stage carbonization were combined as one operation at 840°F and with an oxygen-containing gas for fluidization treatment. Chars with sulfur contents as low as 0.2% were produced. Typical product yields from carbonization, based on dry coal feed, were as follows (wt %): char, 63; tar, 13; fuel gas, 8; acid gas, 11; and water, 5. Unbeneficiated Illinois coal was hydrogenated noncatalytically at a temperature of 840 to 880°F and pressure of 3000 psig. The hydrogenator effluent was processed through a vapor stripper whereby a solids-free overhead was obtained, together with a solids—laden bottoms product. Pelletized formcoke was produced from carbonization char and a binder consisting of SRC-I product that was fluxed with process oils to produce a workable softening-point product, on the order of 140 to 170°F. The binders were upgraded by a treatment schedule comprising airblowing and thermal soaking, both at elevated temperatures. Pellets made from a green mix containing about 30% of the treated binder, and that were processed through the curing and calcining cycles to produce a low-volatile-matter product, had a crushing strength greater than 700 pounds and ASTM stability and hardness values of about 56 and 73, respectively. A material balance showed 78% recovery of formcoke from the green pellets.

DESULFURIZATION AND PURIFICATION

49433 **More coal per ton.** Lihach, N.; Ehrlich, S. *EPRI J.*; **4**: No. 5, 6-12(Jun 1979).

Despite the benefits of clean coal, only about 20% of the nearly 500 million tons used yearly by the utility industry is cleaned; the rest is used raw. But, a tangle of developing circumstances - including higher coal prices, diminishing coal quality, increasing coal use, and mounting environmental awareness - are tipping the balance in favor of coal cleaning, according to Shelton Ehrlich, who heads EPRI's Fluidized Combustion and Coal Cleaning Program. The status of coal-cleaning operations and incentives are discussed. Coal-preparation engineers pursue two major goals: improving removal of impurities (ash-producing minerals, sulfur, moisture) and reducing Btu loss. The research necessary to achieve better ash and sulfur rejection and increased Btu yields is sizable, and not cheap. but if better ways can be developed with only small increases in capital and operating costs, the potential benefits to utilities are no less sizable. Better ash and sulfur rejection leads to better fuel, lower shipping costs, improved boiler reliability and availability, and emission control alternatives. Increased-Btu yields lead to lower mining costs, and because coal is sold on a highly competitive, buyer's market basis, these savings will be promptly reflected in lower coal prices, Mr. Ehrlich feels.

GASIFICATION

REFER ALSO TO CITATION(S) 49460, 50340, 50352

49434 (BNL—51011) **Alternative process schemes for coal conversion. Progress report No. 1, October 1, 1978—January 31, 1979.** Sansone, M.J. (Brookhaven National Lab., Upton, NY (USA)). Feb 1979. Contract EY-76-C-02-0016. 36p. P 03/MF A01.

On the basis of simple, first approximation calculations, it has been shown that catalytic gasification and hydrogasification are inherently superior to conventional gasification with respect to carbon utilization and thermal efficiency. However, most processes which are directed toward the production of substitute natural gas (SNG) by direct combination of coal with steam at low temperatures (catalytic processes) or with hydrogen (hydrogasification) will require a step for separation of product SNG from a recycle stream.

The success or falure of the process could well depend upon the economics of this separation scheme. The energetics for the separation of mixtures of ideal gases has been considered in some detail. Minimum energies for complete separation of representative effluent mixtures have been calculated as well as energies for separation into product and recycle streams. The gas mixtures include binary systems of H_2 and CH_4 and ternary mixtures of H_2, CH_4, and CO. A brief summary of a number of different real separation schemes has also been included. We have arbitrarily divided these into five categories: liquefaction, absorption, adsorption, chemical, and diffusional methods. These separation methods will be screened and the more promising methods examined in more detail in later reports. Finally, a brief mention of alternative coal conversion processes concludes this report.

49435 (FE—2032-9) **Sulfur resistant methanation catalyst. Final report, July 1, 1975—January 31, 1978.** Hausberger, A.L.; Kustes, W.A. (Catalysts and Chemicals, Inc., Louisville, KY (USA)). 20 Apr 1978. Contract EX-76-C-01-2032. 73p. P 04/MF A01.

The purpose of this work was to develop a catalyst which would methanate a gasified-coal stream without prior sulfur removal. Fifty-eight activity tests have been completed on forty-nine different catalyst compositions which were studied as sulfur-resistant methanation catalysts. Most of the base-metal catalytically-active, transition elements were used to prepare the catalysts. These metals were combined or used singly with carriers such as alumina, silica, chromium oxide, magnesium oxide, magnesium silicate, and magnesium aluminate to provide the test catalysts for this work. In addition, a number of catalysts of identical chemical composition were prepared by several formulation methods. Test conditions, including temperature, gas composition, and steam levels were varied during the course of the work and computer data processing was used to analyze the test results. Two catalysts, namely nickel and chromium on magnesium silicate and nickel and chromium on magnesium aluminate, converted all of the carbon monoxide and part of the carbon dioxide to methane at 500°F when reduced with only hydrogen and no sulfur in the process gas. This is equivalent to the performance of nickel-SNG type methanation catalysts. After sulfiding, the nickel—chromium on magnesium silicate catalyst retained a 60 to 80% methanation activity at 1100°F with low steam/gas ratios. It is important to note that 60 to 80% methanation activity has only been achieved when testing at 1100°F. The final stages of a multiple reactor system usually operate at lower temperatures, 500 to 700°F, where the equilibrium for the methanation reaction is more favorable, resulting in minimal carbon monoxide and hydrogen contamination of the product methane. Since a low temperature activity in the presence of sulfur was not obtained, it was recommended this research be abandoned. (LTN)

49436 (FE—2229-10-T1) **Surface structure and mechanisms of gasification catalyst deactivation. Quarterly report, May 1—July 31, 1978.** Reucroft, P.J.; Bradley, E.B.; DeAngelis, R.J.; Sargent, G.A. (Kentucky Univ., Lexington (USA)). Nov 1978. Contract EX-76-C-01-2229. 74p. P 04/MF A01.

Laser spectral studies of the adsorption of CO, O_2, H_2 and D_2 on Ni(111) are discussed in relation to graphitic adlayers and Ni surface states. No definite conclusion is made on which of these mechanisms would produce the dispersion in $\Delta\nu$ observed with variation in excitation frequency. The adsorption cell which will be used during infrared reflection studies of adsorbed gases on Ni(111) is described. Criteria for its design indicate that the infrared cell should maximize spectral response while minimizing scattering losses. Further reduction experiments have been carried out to study the sintering behavior of catalyst C150-1-01. Data showing the effects of sintering temperature and times of sintering on the particle size distribution functions by x-ray line broadening analysis are presented and discussed. An upgrading of the capabilities of the ESCA spectrometer is described. A series of Cr compounds (Cr, Cr_2O_3, Cr(OH)/sub x/, Cr_2S_3, and $Cr_2(SO_4)_3$) have been examined. Analysis of the sulfided Ni—Cr/$MgSiO_3$ catalysts has continued. A simple model of the Ni/Al_2O_3 catalyst is proposed. Auger electron spectroscopy has been used to obtain adsorption isotherms for CO on a S poisoned Ni(111) single crystal surface. The anomalous behavior of the isotherm obtained at about 100°C as compared to those obtained at both lower and higher temperatures, together with desorption data, was interpreted as showing that CO dissociates on the surface to form C and O.

49437 (FE—2247-21) **Gasification of residual materials from coal liquefaction. Evaluation of SRC II Vacuum Flash Drum Bottoms from Powhatan coal as a feedstock for the Texaco gasification processes.** Robin, A.M. (Texaco, Inc., South El Monte, CA (USA). Montebello Research Lab.). Mar 1979. Contract EX-76-C-01-2247. 10p. P 02/MF A01.

A laboratory evaluation of a 20-pound sample of Vacuum Flash Drum Bottoms from the SRC II Plant at Ft. Lewis, Washington was completed. The sample, which was obtained from the liquefaction of Powhatan coal, was judged to be a suitable feedstock for the Texaco Synthesis Gas Generation Process. It can be charged directly to the gasifier at a temperature of about 615°F. The material is too viscous to be pumped with the pilot plant equipment, however, which is capable of maintaining a temperature of only 515°F. The addition of 3 to 5 percent cutter will be required for the pilot plant tests. No cutter will be required for a commercial plant. Based on these results, operating conditons and yields were estimated for gasifying 1000 pounds per hour of molten undiluted residue at 350 psig. A Type II preliminary pilot plant evaluation is planned.

49438 (FE—2355-2(Rev.J)) **Coal gasification valves: Phase II. Quarterly technical progress report, December 1978—February 1979.** (Consolidated Controls Corp., El Segundo, CA (USA)). Mar 1979. Contract EX-76-C-01-2355. 20p. P 02/MF A01.

The Type III S/N 2 Valve was acceptance tested, and a structural problem was discovered when the ceramic gate seal disc cracked at 1615 psi pressure. The seal disc has been redesigned and reordered, and is presently scheduled for delivery in mid-April, 1979. The Type III S/N 1 Valve refractory lining was removed. The lining will be recast as the most expedient method of correcting the internal geometry. The first two Type I, II, IV valves were assembled and acceptance tested. Both valves were well within specification, and no unusual occurrences were observed. As a result of the Design and Interface meeting, the control interfaces of the valve are being modified to accommodate the METC control system. This modification involves minor rewiring of the purge control, plus installation of some relays.

49439 (FE—2778-4) **Engineering support services for the DOE/GRI coal gasification research program. Quarterly technical progress report, October—December 1978.** Cover, A.E. (Pullman Kellogg, Houston, TX (USA)). Jan 1979. Contract ET-78-C-01-2778. 52p. P 04/MF A01.

The objective of this contract is to provide engineering support services to the Department of Energy/Gas Research Institute in the high Btu coal gasification research program. The gasification research program is to determine the specific process and/or combination of component processing steps that offer the greatest economic potential for commercial application. Kellogg has assembled a task team and formulated plans for managing this program so that Kellogg can be quickly responsive to the needs of the Department of Energy/Gas Research Institute (DOE/GRI) and the program contractors. Kellogg has visited all of the Pilot Plants and Process Development Units (PDUs) presently involved in the DOE/GRI high-Btu coal gasification programs. Monitoring and evaluation activities have begun with recent tests at the Hygas and BI-GAS pilot plants and the Westinghouse PDU. A metallurgist has been assigned to follow the activities of the Metal Properties Council in materials testing in the coal gasification environment.

49440 (FE—3125-2) **Advanced development of a short-residence-time hydrogasifier. First quarterly technical progress report, September 30, 1978—December 31, 1978.** Friedman, J. (Rockwell International Corp., Canoga Park, CA (USA). Environmental and Energy Systems Div.). Jan 1979. Contract ET-78-C-01-3125. 75p. P 04/MF A01.

Design for facility modifications was initiated and completed. The facility will be moved from its former Rocketdyne test site to the ESG Energy Bowl Control Center. Subcontract effort for site preparation was initiated in October and is currently ongoing. Disassembly and relocation was started at the conclusion of the low hydrogen/coal ratio injector concept testing. Reassembly, plus the modifications to support the longer duration testing, is scheduled to be completed approximately on March 1, 1979. Specifications were prepared for the fabrication of a new high pressure coal feeder and for the modification of the existing low pressure batch feeder. Specifically, two new types of 1/4-TPH injectors were designed to meet the following requirements: (1) optimum mixing of the hydrogen and coal jets at a H_2/coal weight ratio of 0.25, (2) option to feed supplementary oxygen, either into the preburner or into the reactor chamber through the face of the injector, and (3) structural and operational stability during the projeced 1-hr operation per test run. Six reactor tubes, three having 15-ft lengths and the other three having 7.5-ft lengths, were designed to mate with the new injectors. Other components in the process of design are (1) and additional 4 ft long water-spray quench section to provide longer residence time for water droplet evaporation, and (2) and 11.5 ft long heat-recovery quench section having a shell-and-tube straight-through design with hydrogen as the cooling fluid.

49441 (FE—3240-T1) **Shift conversion and methanation in coal gasification: bench scale evaluation of a sulfur resistant catalyst. Quarterly progress report, October 1—December 31, 1978.** McCarty, J.G.; Meeker, D.; Wise, H. (SRI International, Menlo Park, CA (USA)). 10 Feb 1979. Contract ET-78-C-01-3240. 25p. P 02/MF A01.

For the deactivation studies parallel integral reactors are being built. Different catalysts are given identical pretreatment and exposed to identical feed gas flow rates, gas compositions, and reaction conditions. The degree of CO consumption and CH_4 pro-

duction is determined by measuring the composition of the effluent from each reactor. Relative resistance of the catalysts to poisoning is found by comparing the time required for a given degree of deactivation (e.g., 50% activity loss). Also the thermocouple array in each reactor records the movement of the reactive zone as the catalyst bed is poisoned. From data provided by the temperature profile versus time curve and the methane yield versus time curve we should be able to model the poisoning process in each catalyst bed. The integral reactor system is now being constructed. A sketch of the tube reactors is given. The schematic diagram of the integral reactor system also depicts the Berty reactor system. Both systems use the same analytical instruments and procedures.

49442 (HCP/T—30/2) **Low Btu gas industrial application analysis. Final report.** Phipps, H.R. Jr.; Canete, D.W.; Crowell, J.J.; Rebello, W.J.; Smith, D.M. (Systems Consultants, Inc., Washington, DC (USA)). Mar 1979. Contract ET-78-R-01-3012. 70p. P 04/MF A01.

The purpose of this report is to identify the location and energy requirements of industrial establishments that are potential users of low Btu gas and to assess the national and regional impact of the potential substitution of low Btu gas for oil, natural gas and the direct combustion of coal. Estimates of the low Btu gas potential were based on a plant level technical analysis using data available from published and unpublished sources. These estimates were summarized so that national and regional impacts could be assessed. The impact analysis determined the industry pattern of low Btu gas potential, the geographical distribution of the potential, the size of both the national and regional impact, and the impact of low Btu gas potential on current industrial fuel consumption patterns. An Energy Descriptive Index was developed for use in the impact analysis to determine the geographical distribution and scale of impact if low Btu gas were substituted for current fuels. The Index is sensitive to the mix and amount of energy fuels consumed. The study shows that there is a substantial potential for the industrial application of low Btu gas, especially in the chemical, primary metal and petroleum industries. The technical estimates indicate that 44% of current industrial direct heat and process steam energy requirements and 27% of total industrial energy consumption can be saved bysubstituting low Btu gas for current fuels. Further study, including an economic analysis, will be necessary to identify the market for low Btu gas.

49443 (SAN—1472-18) **Underground gasification for steeply dipping coal beds. Quarterly progress report, July 1—September 30, 1978.** (Gulf Research and Development Co., Pittsburgh, PA (USA); TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). Oct 1978. Contract EF-77-C-03-1472. 74p. P 04/MF A01.

On-site (North Knobs, Wyoming) activities centered around geologic and hydrologic drilling and baseline environmental data acquisition. Design of an all-weather access road was completed and construction is pending. An accelerated burn schedule was planned and budget costs were revised to reflect this change. The Permit to Mine application has been finished and will be filed with the Wyoming Department of Environmental Quality early in October. Research on additional back-up sites continued. The Project Data Book (referred to in earlier documents as the Blue Book and the Test Design Criteria Handbook) format was refined and updated copies were issued. Offsite engineering activities included completion of the instrumentation system requirements and development of a preliminary layout of the site.

49444 (SAN—2069-1) **Support research on chemical, mechanical, and environmental factors in underground coal gasification. Quarterly report, January 1, 1979.** Edgar, T.F.; Humenick, M.J.; Thompson, T.W.; Gray, K.E. (Texas Univ., Austin (USA)). 1 Jan 1979. Contract ET-78-S-03-2069. 50p. P 03/MF A01.

Three subprojects in chemical engineering research have been undertaken with DOE support. They include thermal cracking of tars, combustion tube operation, and mathematical modeling. However, there are actually a total of eight different subprojects underway, including lignite pyrolysis, char gasification, char oxidation, linear combustion rates, and cavity tracer analysis, in addition to the three mentioned earlier. These projects are intimately related to each other and have been undertaken with support of private industry. A brief status report is given on the three DOE sponsored research projects. An adequate knowledge of the thermal properties of the rocks forming a gasification chamber is needed for many areas of gasification simulation. Thus the thermal conductivity is needed to determine temperature fields within the lignite, and in the over and underlying rocks, to allow calculation of heat losses and process development. This parameter, together with the thermal expansion coefficient of the rock, is needed to calculate the thermal stressing effect. The influence of reaction temperatures on the stress field around a gasification chamber is illustrated by considering a simplified model. The three lignite samples under investigation have been ashed and charred at the appropriate temperature for study. Extractions at 20°C using simulated groundwater have been completed for the prepared materials at two of the three burn temperatures. One series of extractions have been analyzed for inorganic releases. This data is being analyzed. Extractions of char samples have also been analyzed for both inorganic and organic releases.

49445 **Catalytic effect of Ni and K_2CO_3 in the gasification of carbon and coal.** Guzman, R. Notre Dame, IN; Univ. of Notre Dame (1979). 216p. L 79-08378.

Thesis (Ph. D.).

The importance of catalytic gasification of coal is highly recognized today. A theoretical-experimental study of this catalyzed gas—solid reaction was performed. In the experimental part, the catalytic effect of nickel and K_2CO_3 on the gasification of activated carbon and Illinois N°6 coal was studied at atmospheric pressure and temperatures between 500 to 927°C, using a Cahn RG electrobalance. Nickel was found to be a very active catalyst in the gasification of activated carbon, producing CH_4 in hydrogasification and mainly CO_2 and CO in steam gasification. In coal, however, nickel exhibited very low activity, probably due to sulfur poisoning. The experimental data using nickel as catalyst was well correlated by a kinetic model in which H_2 or H_2O chemisorption or dissociation is assumed as the rate determining step. The model also predicts that the gasification rate is first order with respect to carbon concentration. The calculated apparent activation energies, 10 Kcal/mol for hydrogasification and 46.8 Kcal/mol for steam gasification, are lower than the values usually reported for the uncatalyzed reactions, indicating that the catalytic effect of nickel decreases the energy barriers necessary for the reactions to occur. The catalytic effect of K_2CO_3 on the steam gasification of activated carbon and coal was also investigated. It was found that K_2CO_3 is a good catalyst in both carbon samples. However, its activity was less than the activity observed for nickel in activated carbon. The main products of the reaction are again CO_2 and CO. As in the nickel case, methane production was minimal due to equilibrium thermodynamic restrictions at the operating pressure used. The experimental data for K_2CO_3 was well correlated by a kinetic model in which it was assumed that the reaction rate decreases as the gasification proceeds due to loss of contact of the catalyst with the reactive solid.

49446 **Affects of various parameters on monolithic refractory linings for coal gasifiers.** Zimmer, C.R.; Anderson, E.M. (Babcock & Wilcox Co., Lynchburg, VA). Contract EX-76-C-01-2218. *Ind. Hect. (Pittsburgh);* **45**: No. 11, 30-31, 34(Nov 1978).

A study is underway at Research and Development Div., B & W, to determine if reliable, crack free monolithic refractory lining configurations can be developed for use to 2000°F in non-slagging coal gasification process vessels. The scope of this program, sponsored by DOE, includes designing and constructing a pressure vessel, lining it with typical coal gasification process vessel linings and monitoring the performance of these linings in air at one atmosphere and in steam at 100 psi or higher during the initial heat-up cycle. Described in this article, which is from a paper presented during the 14th University Conference on Ceramic Science, held at North Carolina State University, are influences of some of the processing variables on lining properties and performance.

49447 **Coal conversion instrumentation.** O'Fallon, N.M.; LeSage, L.G.; Lau, T.K.; Powell, J.L. Jr. (Argonne Natl Lab, Ill). *Ind. Res./Dev.;* **20**: No. 6, 101-104(Jun 1978).

Scientists at Argonne National Laboratory (ANL) now are testing newly developed instruments for mixed-phase flow measurement on process streams in the "Hygas" coal gasification pilot plant in Chicago. Initial tests on a coal/toluene slurry feed line have shown that a capacitive instrument developed at ANL gives a rapid indication of flow speed by cross correlation of signals from separated electrodes, Acoustic noise background levels and signal attenuation measured in the slurry line indicate that a flow instrument using acoustic signals will be feasible for certain frequencies. These instrument tests are part of a continuing program in instrumentation and process control for coal conversion at ANL, funded by the Dept. of Energy.

49448 **Effect of solid chemical composition on coal char reactivity in a carbon dioxide atmosphere.** Muralidhara, H.S. Morgantown, WV; West Virginia Univ. (1978). 144p. L 78-16985.

Thesis (Ph. D.).

Reactivities of coal chars were measured in CO_2 at the temperatures 800°C to 1100°C. The reactivities of the chars were measured in a thermogravimetric analyzer up to complete conversion for most of the samples. In order to insure a kinetic regime, particle size and bed effects were studied, and appropriately maintained thereafter. The physical characteristics of the chars were studied by electron microscopy, X-ray diffraction and BET surface area techniques. The chemical properties of the chars were obtained by atomic absorption spectrophotometry, infrared spectroscopy, and standard ASTM techniques. Coal chars were doped with salts of calcium, magnesium, iron, aluminum, and sodium to study their catalytic effect on the carbon—CO_2 reaction. Three different types of doping techniques were performed. A solution impregnation technique gave the maximum increase in reactivity.

49449 (COO—4563-01(Rev.)) **Environmental noise assessment for synthane pilot plant.** Yen, T. (Pittsburgh Univ., PA (USA). Dept. of Industrial Environmental Health Sciences). [nd]. Contract EY-77-S-02-4563. 29p. P 03/MF A01.

Environmental noise data were obtained at eleven selected sites around the SYNTHANE Pilot Plant at Bruceton, Pennsylvania. The data revealed that noise emission from the plant has a significant impact upon an area as far as about a mile to the east of the plant. It is recommended that additional data be obtained when the plant is operating at its design capacity.

LIQUEFACTION

REFER ALSO TO CITATION(S) 49437, 49456, 49457

49450 (CONF-790822—3) **Modeling the fluid dynamics of the H-coal reactor.** Vasalos, I.A.; Bild, E.M.; Tatterson, D.F. (Amoco Research Center, Naperville, IL (USA)). 1979. Contract EF-77-C-01-2588. 79p. P 05/MF A01.

From 87. AICHE national meeting; Boston, MA, USA (19 Aug 1979).

A key feature of the H-coal process is the use of an ebullated bed for achieving good mixing between slurried coal, hydrogen, and extruded catalyst particles. The H-coal reactor can be modeled as a four-phase fluid bed system containing liquid, fines, gases, and catalyst particles. In order to study the hydrodynamic behavior of this gas/slurry/catalyst system, a cold flow model was constructed consisting of a glass reactor 15.24 cm in ID and 6 m long. A recycle cup located in the upper part of the reactor is used for the partial separation of gas from the slurry before part of the slurry is recycled to the bottom of the reactor. The layout and dimensions of this unit are very similar to a 3 T/D coal liquefaction process development unit (PDU) successfully operated by Hydrocarbon Research, Incorporated (HRI). Using kerosene, pulverized coal char, and nitrogen, it has been found that at ambient conditions the bed expansion of cylindrical catalyst extrudates 1.6 mm in diameter and 4.8 mm in length closely simulates the behavior of the H-coal reactor. Operating conditions which favor the distribution of the gas phase in the stable ideal bubbly regime are also described.

49451 (FE—2514-M2) **Developmental research program for clean industrial and transportation fuels from coal.** Schindler, H.D.; Long, R.H. (Lummus Co., Bloomfield, NJ (USA)). Feb 1979. Contract EF-76-C-01-2514. 65p. P 04/MF A01.

The integrated coal liquefaction facility was operated to first demonstrate solvent self-sufficiency on equilibrium paste solvent. A coal paste consisting of 70 weight percent hydrogenated start-up paste oil and 30 weight percent coal was used to generate an initial solvent inventory. This paste oil pool was then used for all subsequent operations. Solvent self-sufficiency on equilibrium solvent as monitored by a combination of elemental analyses, physical properties, analytical distillations, and spectrophotometric measurements was demonstrated. With equilibrium paste solvent available, a catalyst life study was initiated and completed. Operations on catalyst life testing were concluded at the request of DOE at a coal throughput of 1,567 pounds of coal per pound of catalysts. The sulfur, nitrogen, and ash results for operations at a throughput of just over 1200 pounds of coal per pound of catalyst are listed. When employing a catalyst replacement mode of operation, the projected results indicate that a nitrogen level of 0.5 weight percent would permit the processing of 1,653 pounds of coal per pound of catalyst equivalent to a catalyst consumption of 1.21 pounds of catalyst per ton of coal. Nitrogen levels are controlling, since a sulfur level of 0.3 weight percent (with catalyst replacement) would permit a throughput of 6,010 pounds of coal per pound of catalyst - a catalyst consumption of 0.33 pounds per ton of coal. Confirming the anticipated benefits of operating the hydroliquefaction reactors in a manner approaching plug flow, the hydrogen consumptions during the catalyst life study period ranged from 2.3 to 3.1 weight percent on coal for the yield structures reported herein.

49452 **Disproportionation of a neutral metal—formyl complex and synthesis of a stable hydroxymethyl—metal compound.** Casey, C.P.; Andrews, M.A.; McAlister, D.R. (Univ. of Wisconsin, Madison). *J. Am. Chem. Soc.;* **101**: No. 12, 3371-3373(6 Jun 1979).

In a brief communication to the editor investigations into the proposed mechanisms of the reduction of coal-derived carbon monoxide—hydrogen mixtures via the Fischer—Tropsch and related reactions are described. The Cannizzaro-like disproportionation of the neutral formyl complex $(C_5H_5)Re(CO)(NO)(CHO)$ to give the dimeric metallo ester $(C_5H_5)(CO)(NO)ReCH_2OC(O)Re(CO)(NO)(C_5H_5)$ and the indirect hydrolysis of this ester to give the first stable authentic hydroxymethyl complex $(C_5H_5)Re(CO)(NO)(CH_2OH)$ are described. Hydroxymethyl—metal complexes have been considered as intermediates in CO reduction but have previously been unavailable for study. Identifications of the complexes were made using IR, ^1H NMR and mass spectrometry. A reaction mechanism based on the results is introduced as the possible route for metal catalyzed CO reduction.

49453 **Fuels from coal by SRC-II processing.** Jackson, D.M.; Schmid, B.K. (Gulf Mineral Resources Co., Denver, CO). *Ind. Heat. (Pittsburgh);* **45**: No. 11, 15-17(Nov 1978).

Coal liquefaction through solvent refining produces clean fuels having no ash, low sulfur content, and a considerably higher heating value than coal; permits use of abundant high-sulfur coal; utilizes proved chemical processing technology and experiences, and places increased reliance on domestic energy supplies. Recently, DOE has awarded Denver-based Pittsburgh & Midway Coal Mining Co., a subsidiary of Gulf Oil Corp., and Southern Company Services, the technical subsidiary of Atlanta-based Southern Company, contracts to design and potentially build and operate the first modules of commerical-scale plants. The solvent refined coal (SRC) plant to be designed by the Gulf subsidiary will convert coal into liquid and gas fuels. Each of the first module plants would convert about 6000 tons of coal per day into a low-sulfur, nearly ashless fuel, equivalent to 20,000 barrels per day of crude oil. Scale-up of the SRC technology comes after more than 4 years of testing at two smaller-scale pilot plants: a 50 ton-per-day facility at Ft. Lewis, Washington and a six ton-per-day unit at Wilsonville, AL. In this article, which is from a paper presented at the Fifth Energy tecnology Conference sponsored by Governmental Institutes, Inc., development phases of Gulf SRC-II Process are described as well as the good potential for its industrial application.

BY-PRODUCTS

49454 (COO—4717-2) **Catalytic conversion of oxygenated compounds to low molecular weight olefins. Annual report for January 1—December 31, 1978.** Anthony, R.G. (Texas A and M Univ., College Station (USA). Dept. of Chemical Engineering). Jan 1979. Contract EW-78-S-02-4717. 72p. P 04/MF A01.

The conversion of methanol or synthesis gas is an attractive route for producing ethylene and propylene from coal. Utilizing a chabazite ion exchanged with ammonium and rare earth chlorides, methanol is converted to ethylene, propylene, and propane with carbon yields of 70 to 90% at reaction temperatures of 360 to 450°C and pressures from 1 to 18 atmospheres. Carbon disulfide in the feed at concentrations less than 2000 ppm increases the operating time between regenerations from four hours to twenty hours. At carbon disulfide concentrations of 3000 ppm or greater, the catalyst goes through three stages. The first is that of a dehydrogenation catalyst that produces carbon monoxide and hydrogen. The second stage produces ethylene and propylene, and finally, the third stage is a dehydration catalyst that produces dimethyl ether. Water has no detrimental effect on the catalyst, and appears to enhance its activity. Increase in pressure increases the production of propylene and propane at the expense of ethylene. X-ray diffraction studies show the formation of an ultrastable zeolite. No permanent deactivation was observed even though the catalyst was overheated once, and had been deactivated and regenerated for as many as 21 times. Ethylene yields increase as the temperature increases from 360 to 450°C. When synthesis gas is passed over the catalyst at pressures equal to or less than 500 psi, methane and carbon dioxide are produced.

PROPERTIES

REFER ALSO TO CITATION(S) 50567

49455 (COO—4227-7) **Coal anion structure and chemistry of coal alkylation. Seventh quarterly progress report, September 1, 1978—November 30, 1979.** Stock, L.M. (Chicago Univ., IL (USA)). 1978. Contract EF-77-S-02-4227. 22p. P 02/MF A01.

Two areas of research are discussed. One concerns progress on the alkylation of the coal polyanion obtained from Illinois No. 6 coal using methyl iodide-C^{13} and butyl iodide-1-C^{13}. The other concerns progress on the comparison study of the reactions of tetralin-d_{12} with Illinois No. 6 coal.

49456 (EPRI-FP—1028) **Characterization and combustion of SRC II fuel oil. Final report.** Downs, W.; Kubasco, A.J. (Babcock and Wilcox Co., Alliance, OH (USA). Research Center). Jun 1979. 131p. P 07/MF A01.

This report deals with an experimental evaluation of the SRC II process's principal product, solvent refined coal fuel oil (SRC fuel oil), for use with commercial scale steam generating equipment. The purpose was to identify problems, if any, associated with handling, storing, pumping, and burning SRC fuel oil. Detailed fuels characterization analyses were performed and compared to petroleum distillate products. An industrial boiler rated at a steam flow of 45,000 lbs/hr was utilized for combustion tests. Modifications made

to the boiler facility included connection of an existing air heater to supply combustion air at 400°F, revamping of the boiler controls to permit biasing of the fuel/air ratio, installation of a high pressure mechanical return flow pumping and atomization system, various piping and pump modifications, and installation of various gas and particulate analysis instrumentation. Combustion tests were performed with SRC fuel oil, No. 2 fuel oil, and No. 5 fuel oil. Operating variables included load, excess air, and burner register settings. The laboratory fuel analyses indicated that in most respects this SRC fuel oil sample behaved similarly to No. 2 fuel oil. The combustion test confirmed that SRC fuel oil burns similarly to No. 2 fuel oil with one notable exception, NO/sub x/ emissions were substantially higher than for either the No. 2 or No. 5 fuel oils. It was concluded that SRC fuel oil will require the application of NO/sub x/ combustion control techniques to meet the proposed New Source Performance Standards of 0.5 pound NO_2/million Btu when burned in power boilers equipped with wall-mounted burners.

49457 (FE—2537-9) **Characterization of coal-derived liquids and other fossil fuel related materials employing mass spectrometry. Quarterly report, September 29—December 29, 1978.** Scheppele, S.E. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry). 29 Jan 1979. Contract EX-76-S-01-2537. 19p. P 02/MF A01.

The standard electron multiplier of the CEC 21-110B mass spectrometer was replaced with a Hamamatsu electron multiplier. The change allowed the electron multiplier to be operated at a higher gain with about the same noise level on the output signal as with the standard electron multiplier operating at lower gains. The dynamic resolution of the mass spectrometer was determined when the static resolution was set for a value of 13,000. Field-ionization mass spectra, FI/MS, were obtained for the following saturate fractions: Arco Shale Concentrates, 200-325°C, 325-425°C, and 425°C+; South Swan Hills Concentrate 370-535°C; and Utah Crude Oil No. 72054. The molecular ion intensities in the FI/MS of each sample were converted into carbon number distributions as a function of Z(H). The weight percents across each Z(H) series were summed to obtain total weight percents as a function of saturate type. Steps in completing the interfacing of the Nova 3/12 data acquisition system to the comparator-microdensitometer have been taken. An outline of the steps which have been completed and those which will be completed to implement the interfacing is given. Also preliminary designs are given in this report for the interface circuitry and the interface software. High- and low-resolution field-ionization mass spectral data were acquired for 19 monoaromatic, diaromatic, and polyaromatic polar concentrations. These samples were analyzed for the Separations and Characterization Group at the Bartlesville Energy Technology Center. Also acquisition of high-resolution field-ionization mass spectral data for the remaining asphaltene fractions from the COED coal liquid was completed.

49458 Study of solvent refined coal by elevated temperature carbon-13 Fourier transform nuclear magnetic resonance spectrometry. Dorn, H.C.; Taylor, L.T.; Glass, T.E. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *Anal. Chem.;* **51**: No. 7, 947-951(Jun 1979).

Quantitative ^1H and ^{13}C NMR techniques have been developed which allow measurement of hydrogen to carbon ratios and elemental carbon and hydrogen percentages for coal liquefaction products. Good agreement between the NMR experiment and bulk elemental combustion analysis has been obtained with chromatographic fractions of certain solvent refined coals. For Amax and Monterey SRC, the discrepancy in elemental percentages were much greater; however, these were less prominent at higher temperatures (32 vs. 75°C). In an analogous fashion, inferred ratios of aliphatic-to-aromatic carbon decrease for the lower temperature measurements. These results suggest that certain solutions of coaly matter may experience inhomogeneities. The use of high temperature NMR solvents and high temperature examination of melts of the coal products is described as a viable alternative for ^{13}C NMR investigation of coaly matter.

49459 Analysis of pore structure in Kentucky coals. Debelak, K.A. Lexington, KY; Univ. of Kentucky (1977). 182p. L 78-15734. Thesis (Ph. D.).

The geometric properties of five Kentucky coals were measured from the adsorption of carbon dioxide and mercury penetration. These properties include the surface area, pore volume, and pore volume distribution. Equilibrium times of 24 hours were allowed for the adsorptions made at 195 K and 205 K. The surface areas were evaluated from the BET, Langmuir and Dubinin—Polyani theories of adsorption. Values ranging from 158.1 M^2/gm to 227.2 M^2/gm were obtained. The pore volume distributions determined from carbon dioxide adsorption and mercury penetration agreed well in the range of overlapping pore sizes, from approximately 20 A to 300 A. The distributions are bimodal and trimodal and resemble those found in some commercial catalysts. However, most of the pore structure in coal is in the micropore range. A comparison of two pore models, the cylindrical and parallel plate, indicated that the parallel plate pore model is a better representation of the fine pore structure in coal. The minimum pore diameter determined was 6.4 A which approximates the dimensions of the carbon dioxide molecule. There was also good agreement between the pore volumes obtained from carbon dioxide adsorption and mercury penetration in the region of overlap. The total pore volumes determined from adsorption ranged from 0.114 cm^3/gm to 0.227 cm^3/gm using the parallel plate pore model. The unsteady state diffusion and adsorption of carbon dioxide was examined using the unsteady state diffusion equation which included an additional term to account for the adsorption. This allowed a theoretical prediction of the uptake of carbon dioxide which could be compared with the experimental uptake.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 49853

49460 (METC/CR—79/24) **Biological treatability of gasifier wastewater.** Slack, W.A. (West Virginia Univ., Morgantown (USA). Dept. of Civil Engineering). Jun 1979. 116p. P 06/MF A01.

Condensate from four producer runs was successfully treated by biooxidation after pre-stripping for ammonia reduction. Assuming only simple phenols in the waste, about 43% of the condensate COD was due to phenol equivalent COD. Pre-stripping with lime rather than caustic resulted in somewhat better organic removals and improved setting of the sludge making lime the stripping agent of choice. Phenol and BOD removals were over 99% and 93% respectively even at detention times as low as 0.58 days. Solids residence times of from 4.4 to 18 days were used. Foaming problems during all biological runs required the addition of small amounts of an antifoam agent. Addition of powdered activated carbon (PAC) at a level of 3000 mg/1 in the aerator allowed the biomass to function even under stressed conditions at relatively high ammonia levels. Biological and bio-PAC runs were made using full-strength stripped condensate under non-stressed conditions. Based on the results of this investigation, biological treatment of the condensate would best be accomplished at dilutions of 1:1 to 1:2. Hydraulic residence times should be 24 to 36 hours while solids residence times of 7 to 10 days appear adequate. It should be possible to achieve TOC and COD reductions of around 80%, while removal of BOD and phenol would be over 95 and 99% respectively. (LTN)

49461 Absorption of SO_2 in lime and limestone slurry: pressure drop effect on turbulent contact absorber (TCA) performance. Wen, C.Y.; Chang, C.S. (West Virginia Univ., Morgantown). *Environ. Sci. Technol.;* **12**: No. 6, 703-707(Jun 1978).

Data from a bench-scale and a large-scale TCA were analyzed under high-pressure drop operation and flooding or nonflooding conditions by a refinement of a model developed by W.J. McMichael, L.S. Fan, and C.Y. Wen, Ind. Eng. Chem., Process Des. Dev. 15 No. 3:459-467 (July 1976). The effect of liquid holdup on the scrubbing efficiency was incorporated into this model to include hydrodynamic factors. A fixed bed model was used to simulate the performance of the packed section present in a flooded TCA. Experimental and calculated SO_2 scrubbing efficiencies agreed to within +-5% for both flooding and nonflooding conditions. Thus the correlations developed represent the system closely and can be used for the design and scale-up of TCA scrubbers for SO_2 removal from the flue gas. 23 references.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 49444, 50213, 50565, 50578, 50588, 50603, 50614, 50627

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 49472, 50194

MINING

REFER ALSO TO CITATION(S) 49470, 49473

49462 (CONF-780886—) **Proceedings of the fourth WVU conference on coal mine electrotechnology.** Aldridge, M.D. (ed.). (West Virginia Univ., Morgantown (USA). Dept. of Electrical Engineering). 1 Oct 1978. 521p. P 22/MF A01.

From 4. WVU conference on coal mine electrotechnology; Morgantown, WV, USA (2 Aug 1978).

Thirty-nine papers from the Proceedings have been entered individually into EDB and ERA. Topics covered included mine

power systems, mine instrumentation, mine illumination, mine communications, automatic control and monitoring, regulations, power distribution instrumentation, power distribution equipment, electrical systems for mine trolleys, on-line computer control of mines and monitoring using microprocessors. (LTN)

49463 (FE—9139-T1) **Industrial engineering study of continuous mining systems.** (Davis (J.J.) Associates, McLean, VA (USA)). 8 Aug 1977. Contract ET-75-C-01-9139. 700p. P 99/MF A01.

This study of state-of-the-art in continuous mining included an in-depth understanding of the evolution of continuous mining equipment, their unique features, and their potential. Also included was the determination of the human factors associated with the operation of the equipment, the conditions best suited for the equipment, and all standard operational practices associated with them. This included an examination of the advantages and drawbacks associated with methods utilizing both shuttle car and continuous haulage equipment. This also included documentation of the support requirements for the mining section for each method observed. In depth industrial engineering studies of the basic operations of continuous mining sections were completed including a detailed task analysis of the operations performed by and the interfaces of the continuous miner operator, in-depth studies of all support equipment in an operating section, and the basic operations necessary to describe and evaluate all concepts of an automated continuous mining section. These studies were carefully analyzed and developed into a set of standard data. Next, the performance of support equipment used in a continuous mining section was determined. This information has provided a base to project the reliability of this equipment and its logistic and maintenance requirements. A comparative analysis was conducted to determine which concept developed is optimum considering all of the favorable and unfavorable factors described in the evaluation. (LTN)

49464 (FE/EES—79/6) **Basic estimated capital investment and operating costs for subbituminous and lignite coal strip mines. Mines with annual production of 3, 4, and 5 MMtpy ROM coal.** Berkshire, L.H. (Department of Energy, Morgantown, WV (USA). Process Evaluation Office). Apr 1979. 37p. P 03/MF A01.

This study, prepared by the Process Evaluation Office, Division of Systems Engineering, Fossil Energy, estimates typical capital investments, operating costs, and the required selling prices for coal produced from hypothetical subbituminous and lignite strip mines in the Northern Great Plains province. Annual production for the subbituminous mine is 4 million tons; for the lignite mines, it is 3 and 5 million tons. Wage and union welfare rates are those that went into effect under the Western Coal Wage Agreement of 1977. Costs of materials and equipment are based on first-quarter 1979 indexes. It is assumed that the mines have a 20-year life. Two selling prices for coal were determined for each mine - one based on 12-, 15-, and 20-percent returns on equity, and the other based on the same returns with a debt-equity split of 1:2 with 9 percent interest paid on debt dollars. Investments for the mines are summarized in a table.

49465 **Fire-resistant fluids: their application in British mines.** Myers, M.B. (Century Oils Ltd., Stoke-on-Trent, England). *Can. Min. Metall. Bull.;* **72**: No. 806, 59-67(Jun 1979).

The subject matter of this paper is discussed under three main headings. (1) Fire-Resistant Fluids: (a) the need for such materials, based on historical events; (b) a definition of fire-resistant fluids; (c) general description, characteristics, operational parameters, advantages and disadvantages of oil-in-water emulsions (HFB), water-polymer fluids (HFC) and anhydrous or synthetic fluids (HFD). (2) A review of equipment associated with the use of fire-resistant hydraulic fluids; (a) performance testing of hydraulic equipment, i.e. gear pumps, vane pumps, axial and radial piston pumps, hydraulic motors, etc., pressure, speed, filtration limitations, etc., and effects on valves, elastomers, paints, etc.; (b) hydraulic system design features and selection of suitable units; (c) types of mining applications currently employing fire-resistant fluids. (3) Test methods used to evaluate fire-resistant fluids: (a) fire testing methods, i.e. wick tests, spray ignition testing, hot manifold tests, factory mutual tests, all to establish fire-resistancy parameters and acceptance; (b) new developments in fire-resistancy evaluation; (c) the examination of other performance tests, e.g., effects of evaporation, sliding wear, life of rolling element bearings, etc.

49466 **Effect of physical conditions on continuous miner production in underground coal mines.** Suboleski, S.C. Univ. Park, PA; Pennsylvania State Univ. (1978). 377p. L 79-09138.

Thesis (Ph. D.).

This study is concerned with the development of a mathematical model to predict productivity in underground mines using continuous miners, as a function of eight primary physical variables: seam height, roof quality, methane liberation, bottom quality, water, grades, depth of seam and hardness of seam. These were studied using both simulation and empirical methods. In the former over 50 controlled cases were analyzed and productivity linked to the above variables. The field data were gathered from approximaely 400 operating sections and, after pre-screening by cluster and factor analysis techniques, several linear regression models were derived. The results obtained from the theoretical and field models compared favorably. The field studies generally explained about half the total variation in production, indicating that human and equipment factors may be significant in the determination of the productivity to be attained.

TRANSPORT AND HANDLING

49467 **Coal preparation in New Zealand.** Buckenham, M.H.; Watson, J.L. Auckland, NZ; New Zealand Energy Research and Development Committee (1979). 17p. (NZERDC—43).

This report presents results of a project carried out under New Zealand Energy Research and Development Committee sponsorship (Contract 3099) aimed at assessing the contribution coal preparation could make in increasing reserves and improving quality, to the recovery and utilization of fine coal and in overcoming environmental problems in the coal industry of New Zealand. A survey of production centres revealed a disturbing lack of quantitative and meaningful data relating to the project and this prevented project objectives being achieved. The results of the survey however identified numerous areas where coal preparation could be useful and further work profitable. General industry and specific project recommendations are made some of which however must be considered in the light of technical and economic limitations in the industry.

COMBUSTION

REFER ALSO TO CITATION(S) 49442, 49850, 49856, 50284, 50461

49468 (FE—2018-11) **Fundamentals of nitric oxide formation in fossil fuel combustion. Quarterly progress report, 11 December 1977—28 September 1978.** Houser, T. (Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry). May 1979. Contract EX-76-C-01-2018. 13p. P 02/MF A01.

The pyridine pyrolysis kinetic data were reevaluated by attempting to take into account an apparent increase in catalyst concentration with an increase in temperature at the same extent of reaction. Using this approach the first-order and autocatalytic rate constants and their Arrhenius parameters were recalculated, which gave a much lower activation energy for the catalytic term. The mass spectrometer had an electronic failure and during its down time it was determined that the gas chromatographic technique was not suitable for analyzing the reactant consumption from the oxidation experiments. The mass spectrometer has now been repaired. A reaction mechanism was devised to account for the first-order kinetic term and observed product distribution for the pyridine pyrolysis. This scheme is a radical chain mechanism, which includes a radical rearrangement propagation step as the unique feature.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 49464, 50214

49469 (EPRI-EA—1086) **Design for coal supply analysis system. Final report.** (Charles River Associates, Inc., Boston, MA (USA)). May 1979. 198p. P 09/MF A01.

Coal supply forecasts are used by EPRI to assess the potential of new technologies and by member utilities for strategic planning. Developing realistic coal price—quantity relationships for technology assessment is one type of activity in the EPRI Energy Supply Program, and providing information on coal markets and coal forecasts to member utilities is another. To support activies such as these, EPRI is developing a computerized Coal Supply Analysis System (CSAS). The CSAS contains procedures for developing coal analyses and a data base to support them. The procedures include methods to estimate available coal resources, coal extraction costs, coal preparation costs, and regional coal supply functions, and to support price and production forecasts. The basic data base includes information on coal resources (resources, production), coal mining technology, and coal prices. Procedures are supported by data bases containing information developed from the basic data files or from other procedures in CSAS or other systems (demand, transport). Because CSAS supports analyses produced on a regular basis as well as special analyses, the system should provide flexibility for unanticipated analyses as well as cost-effective methods for frequently used procedures.To provide this capability, there should be a flexible data base management system, a variety of programming languages under a common operating sytem, and the ability to access nonresident programs.

HEALTH AND SAFETY

49470 (BMFT-FBHA—79-04) **Ear protection devics with special regard to their suitability in underground mines.** Asch, H.J.; Heine, K.; Huske, H.J.; Schulte, J.; Zoels, P. (Ruhrkohle, A.G., Essen (Germany, F.R.)). May 1979. 60p. (In German). U 04/MF A01.

The fact that in 1974 there was not yet available any ear portection device specifically adapted to the use in underground coal mines, induced Ruhrkohle AG to carry out a project called "Ear Protection Devices with Special Regard to Their Suitablilty in Underground Mines," from July 1st, 1974 through June 30th, 1976. According to the objectives of the project, two devices were tested and developed on the basis of a list of requirements, i.e., the otoplastic device, Peacekeeper, and a polymer foam ear stop EAR which both had been retained among the devices in the market in 1974. The investigations, i.e., determination of physical, chemical, and bacteriological properties, wear tests and subsequent interviews with more than 300 individuals, had in view both objective and subjective features (comfort of wear, intellegibility of speech, and signals). From the test results the modified and wrapped polymer foam stop EAR seems to be a protecive device which may be widely used even with the difficult conditions prevailing in underground coal mines, whereas the use of the Peacekeeper should be limited to special situations or categories of persons. The wrapped ear stop has thus been a clear improvement compared with the protective devices used hitherto in underground mines. Moreover, the use of the wrapped ear stops is recommended also for work places in comparably difficult conditions outside the coal industry.

49471 **Application of second-derivative UV-absorption spectrometry to polynuclear aromatic compound analysis.** Hawthrorne, A.R.; Thorngate, J.H. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Appl. Spectrosc.*; **33**: No. 3, 301-305(May 1979).

The increased awareness of the deleterious effects of polynuclear aromatic (PNA) compounds emphasizes the need for instruments that are capable of monitoring these compounds and also are suitable for use in health protection programs. Second-derivative UV-absorption spectrometry with least-squares spectral analysis shows promise as a method for analyzing vapor phase PNA's, as well as solutions containing these compounds. Detection limits of a few parts per billion are attainable for many PNA compounds. Examples are given showing the analytical capabilities of this procedure.

REGULATIONS

49472 (EMD—79-47) **Issues facing the future of Federal coal leasing.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 25 Jun 1979. 265p. General Accounting Office, Dist. Section, Rm 1518, 441 G Street, NW, Washington, DC.

Report to the Congress of the United States by the Comptroller General.

This report identifies and analyzes a broad range of issues affecting the development and implementation of a sound Federal coal management program, particularly the use of Western coal in meeting America's energy needs. On June 4, 1979, the Secretary of the Interior announced a new Federal coal program, calling for a resumption of competitive leasing for the first time since a moratorium was imposed in 1971. Leasing is to take place beginning in January 1981. But--as the report points out--many questions remain unanswered, some of which GAO believes need to be resolved before further long-term leasing can take place. Others can be worked out during the early stages of the new leasing program. GAO believes early consideration and resolution of these issues is needed for a coal program that responds to national needs expeditiously, and in the most effective way.

49473 (NP—23811) **Survey of the industry: impact of the proposed OSM regulations.** (Mining and Reclamation Council of America, Washington, DC (USA)). Feb 1979. 7p. K .

The results of the survey indicate that the pre-mining survey, permit requirements and reclamation standards portions of the regulations appear most detrimental to the industry, followed closely by the bonding and design criteria portions. Because the final regulations have not yet been published and will not go into effect for some time, it is difficult to obtain an accurate evaluation of the economic impact of the regulations on the surface coal mining industry. Thus, it was not surprising that when we asked the industry to project their increased operating costs resulting from the proposed regulations, we obtained a wide range of estimates. In fact the range is so wide and the analysis resulting in many of the estimates so shallow that definitive estimates are inappropriate at this time. We can say however that most estimates exceeded a 100% cost increase and a majority in mine size categories II, III, and IV exceed 300%.

PETROLEUM

49474 **ANEP 1977.** Hamburg, Germany; Otto Vieth Verlag (1977). 228p. (In several languages).

The contents of the book are divided into 4 main parts entitled Topical features; Europe in figures; Lists of firms; and Suppliers directory and buyers guidel Each part is further divided with the first part covering the topics; Development of the primary energy supply in Western Europe; The Soviet Union's petroleum industry; Situation and Prospects of offshore drilling; Petrochemicals into 1980's - prices, proportions, problems; and World LNG trade - present status and long term prospects. Part 2 includes discussion of the topics, Crude oil and natural gas in the North Sea, Map of gas and oil fields in the North Sea, Lists of refineries in Western Europe, Maps of refineries and pipelines in Europe, Crude oil products pipelines in Western Europe, Natural gas pipelines within the European natural gas system, East European countries: Oil and gas fields, reserves, refinery locations and capacities, Map of Soviet Union's refineries, Oil and natural gas pipelines, Map of Eastern Europe's refineries, Oil and natural gas pipelines, European oil and natural gas statistics in a worldwide comparison, and oil statistics for the individual European countries including the Eastern Bloc. The titles for Parts 3 and 4 are self-explanatory.

RESERVES

49475 (CONF-790729—1) **Sampling proportional to random size.** Uppuluri, V.R.R.; Patil, S.A. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.; Tennessee Technological Univ., Cookeville (USA). Dept. of Mathematics). 1979. Contract W-7405-ENG-26. 13p. P 02/MF A01.

From 2. international conference on mathematical modeling; St Louis, MO, USA (11 Jul 1979).

Let X_1, X_2,...,X/sub N/ be N nonnegative i.i.d. random variables. Let Y_1 = X/sub α/ with probability X/sub α/(X_1 + ... + X/sub N/), α = 1,2...N. This is referred to as the first realization when sampling with probability proportional to size. Next Y_1 is deleted from $X_1, X_2, ..., X$/sub N/ and other observation, Y_2, is made similarly. It is of interest to find the distributional properties of the sequence $Y_1, Y_2, ..., Y$/sub n/ (n $\leqq$ N). These properties are used by E. Barouch and G.M. Kaufman in order to estimate recoverable oil resources. The distributional properties of ($Y_1, Y_2, ...$ Y/sub n/) are presented for the case when X/sub α/ has a general distribution, and specialized for the case when X/sub α/ has a gamma distribution. The distributional properties of Y/sub n/ are also obtained given the immediate past y/sub n-1/; these results supplement the distributional properties of Y/sub n/ given $y_1, y_2, ..., y$/sub n-1/.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 50194

49476 **Remote sensing of natural resources. Quarterly literature review, January—March 1979.** Albuquerque, NM; Univ. of New Mexico (1979). 172p. (TAC-RS—79-001).

Information is presented under the following section headings: introduction; user guide; information sources; recent releases; and, literature review. The literature reviewed includes abstracts when available on the following subjects: general; geology; environmental quality; hydrology; vegetation; oceanography; regional planning and land use; data manipulation; and instrumentation and technology. An author index and document order form are included. (JGB)

DRILLING AND PRODUCTION

49477 (FE—2025-38) **Naturally occurring carbon dioxide sources in the United States. A geologic appraisal and economic sensitivity study of drilling and producing carbon dioxide for use in enhanced oil recovery.** Zimmerman, F.W.; Perry, C.W. (Gulf Universities Research Consortium, Bellaire, TX (USA)). Jan 1979. Contract EX-76-C-01-2025. 137p. P 07/MF A01.

Large accumulations of gas containing high percentages of naturally occurring subsurface carbon dioxide are located in several geographic provinces of the United States. Central Mississippi, West Virginia, the Delaware—Val Verde Basins of West Texas and several locations in the Rocky Mountains contain gas deposits with high percentages of carbon dioxide. Preliminary characterizations of reservoir rock quality and gas composition were performed for these areas. Four significant accumulations of carbon dioxide were chosen for in-depth geologic, reservoir, and economic analyses. Anticipated

flowing pressure, sustained flow rates, recovery efficiencies, original gas in place, and reserves were determined. Sensitivity studies designed to bracket a possible range of prices were generated, utilizing estimated development and production costs, for each of the four areas. Projections of the potential supply, profitability of drilling and producing, and preliminary analysis of potential demand for naturally occurring carbon dioxide are presented.

49478 (NP—23856) **Catalog of subsurface information for West Virginia. Mineral Resources Series, No. 6.** Patchen, D.G.; Kline, P.C.; Patchen, M.A.; Cardwell, D.H.; Behling, M.C. (West Virginia Geological and Economic Survey, Morgantown (USA)). Apr 1977. 193p. K.

All wells drilled in West Virginia for which the Survey has samples are listed in order by county and state permit number. Additional data further identify the well, locate it geographically, supply stratigraphic information, and list other material available for use in stratigraphic and petrographic studies. (DLC)

49479 (SAN—1277-2) **"200" Sand Steamflood Demonstration Project. Second annual report, June 1977—June 1978.** (Chanslor-Western Oil and Development Co., Santa Fe Springs, CA (USA)). Jun 1979. Contract EY-76-C-03-1277. 48p. Dep. NTIS, PC A03/MF A01.

The "200" Sand Steamflood Demonstration Project is testing an enhanced steamflooding technique in the Midway—Sunset Field, Kern County California. The "200" Sand Pool made very little primary production and responded poorly to cyclic steam stimulation; therefore, this project was initiated to demonstrate the operational, recovery, and economic aspects of steamflooding a typical heavy oil reservoir which had unfavorable response to cyclic steam stimulation.

49480 **Hydraulic actuated weight set well packer.** Morris, A.J.; Garner, J.K. Jr. (to Camco, Inc.). US Patent 4,141,413. 27 Feb 1979. Filed date 22 Dec 1977. 6p.

A well packer for connection in a well tubing in a well is described in which the body has an internal diameter as great as the tubing in which it is to be inserted and has a tensile strength greater than the tubing. Packing surrounds the body and a longitudinally movable expander is positioned about the body and below the packing and is moveable towards the packing for expanding the packing outwardly. Slips are positioned about the body and adjacent the lower end of the expander means and move outwardly upon movement of the slips towards the expander. An annular piston positioned about the body is longitudinally movable and on upward movement expands the slips and the packing. An annular spring is positioned above the piston and yieldably urges the piston in a downward direction whereby the packer may be set, released from a set position, and reset in the well.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 50195, 50196

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 50070, 50075

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 50590, 50591

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 49496, 50215

49481 (DOE/EIA—0184/10) **Comparison of EIA and IPAA petroleum forecasts for 1978 and 1979. Analysis report.** Trapmann, W. (Department of Energy, Washington, DC (USA). Energy Information Administration). 17 Apr 1979. 24p. P 02/MF A01.

This Analysis Report provides and compares alternate projections of petroleum supply and demand balances for the years 1978 and 1979 and contrasts all of these estimates with recently available actual data for 1978. The Independent Petroleum Association of America (IPAA) forecasts of petroleum product demands for 1979 are lower than either of the Energy Informaion Administration (EIA) projections particularly for residual fuel oil and minor other products. This is due mainly to the fact that IPAA assumed a lower level of economic activity for 1979. Despite the consistently higher demand for total petroleum products according to EIA, the IPAA projection of 7558 thousand barrels per day (MB/D) for motor gasoline demand is bracketed by the EIA figures for low demand, 7435 MB/D, and high demand, 7596 MB/D. Motor gasoline demand is significant since it represents almost 40% of the total demand for petroleum products. The IPAA projections fall within the EIA projection ranges for 1979 domestic crude oil production. The IPAA estimates production will be 8656 MB/D, while the EIA forecasts range from 8583 MB/D to 8808 MB/D. Alaskan crude oil production from the North Slope provides a large share of the domestic total. There is general agreement on the Alaskan projections; EIA estimates North Slope production will be 1200 Mb/D, while the IPAA figure is 1130 MB/D. The projections for petroleum imports are derived from the corresponding estimates for demand and supply. As such, the IPAA projection for 1979 imports excluding US strategic storage activities, lies below the range from the alternate EIA cases. This is attributable mainly to the higher levels of demand embodied in the latter figures. The IPAA value is 8870 MB/D, while the EIA values range from 9043 MB/D up to 9449 MB/D. In addition, the mix of imported petroleum between crude oil and refined products in the forecasts varies in each case.

PROPERTIES

REFER ALSO TO CITATION(S) 49457

49482 (BETC—001-1) **Characterization of high boiling fossil fuel distillates via ^{1}H and ^{13}C NMR analysis. Quarterly report, July 1, 1978—September 30, 1978.** Berlin, K.D.; O'Donnell, D.J.; Sigle, S. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry). 1978. Contract EW-78-S-19-0001. 53p. P 04/MF A01.

The progress to date under the orginal contract centers around the acquisition and analyses of ^{1}H and ^{13}C NMR spectra of the monoaromatic concentrates and GPC (gel permeation chromatography) fractions of Wilmington 209-76 No. 15, 19, 23 and Gach Saran 206-76 No. 14, 18, 22 distillates (535 to 675°C). In addition, the analyses of diaromatic GPC fractions from Wilmington 211-76 No. 19 and Gach Saran 207-76 No. 21 distillates (535 to 675°C) have also been initiated. The completion of these objectives has been slowed somewhat by additional requests by DOE for immediate analyses of fractions isolated from recovered lubricating oils. The results of the investigation of these lubricating oil fractions have also been included in this report, though not strictly a part of the original contract.

49483 (BETC—001-2) **Characterization of high boiling fossil fuel distillates via ^{1}H and ^{13}C NMR analysis. Quarterly report II, October 1, 1978—December 31, 1978.** Berlin, K.D.; O'Donnell, D.J.; Sigle, S. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry). 1978. Contract EW-78-S-19-0001. 63p. P 04/MF A01.

The goals reached in the second quarter of the original contract are the completion of the ^{1}H NMR analysis of all of the concentrates (monoaromatic, diaromatic, polyaromatic-polar and saturates) and GPC (gel permeation chromatography) fractions 211-76 No. 16 and 24 (diaromatic) and 210-76 No. 16, 21 and 26 (polyaromatic-polar) distillates (535 to 670°C) of Wilmington crude and the concentrates and GPC fractions 207-76 No. 15 and 24 (diaromatic) and 208-76 No. 15, 20 and 25 (polyaromatic-polar) of Gach Saran crude. In addition, the ^{13}C NMR analysis was completed of the monoaromatic GPC fractions of Wilmington (209-76 No. 15 and 23) and Gach Saran (Concentrate and 206-76 No. 14, 18 and 22) distillates as well as the ^{13}C NMR analysis of the concentrates of the diaromatic, polyaromatic-polar and saturate fractions of Wilmington and Gach Saran distillates. The acquisition of ^{13}C NMR spectra of the remaining fractions is steadily progressing, although long acquisition times (for example, 63 hours per spectrum) will slow somewhat the rate at which data can be obtained.

NATURAL GAS

REFER ALSO TO CITATION(S) 49474

RESERVES

REFER ALSO TO CITATION(S) 49475

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 49476, 49500, 49501, 50194

49484 (FE—8214-5-T1) **Coordination of study of the Devonian black shale in the Illinois Basin (Illinois, Indiana, and western Ken-**

tucky). Annual progress report, February 1, 1978—January 31, 1979. Lineback, J.A. (Illinois State Geological Survey, Urbana (USA)). 1 Feb 1979. Contract EW-78-S-21-8214. 22p. P 02/MF A01.

This report presents some of the highlights of the New Albany Shale study in the Illinois Basin. A large data base is being generated for future workers to use. Evaluation of much of the data collected has yet to be attempted. Many more data and interpretations of those data will become available before the end of the project. With the exception of the aforementioned problems in the distribution and availability of core, no significant voids in the data being developed are seen. The data being collected will be more than adequate to evalute the potential of the New Albany as a conventional source of natural gas in the Illinois Basin.

49485 Shaly gas-sand analysis using hand-carried calculators. Wu, C.H. (Colorado School of Mines, Golden); Krug, J. *Log Anal.;* **20**: No. 3, 20-25(May 1979).

A well log evaluation program is presented in this article for shaly-sand cross-plot analysis using either the Hewlett Parkard HP-97 or HP-67 calculator. This program uses analytic methods to compute the effective porosity and shale content from a density (rho/sub b/) and a neutron log porosity (phiN) cross-plot. When hydrocarbon effect is significant, the gamma ray log or spontaneous potential log response is used to compute a shale-corrected, and consequently, hydrocarbon-corrected porosity. First the porosity and shale content are computed, then the water saturation is calculated using the total shale formula. The program has been tested on low permeability (tight) gas-sand analysis and the results are comparable with SARABRAND sand-shale analysis. The accuracy and versatility of the program allows the user to: (1) evaluate shaly formations accurately and quickly in the field and to assist on-site decisions for formation tests and completion; and (2) determine the effect of log parameters on the porosity and saturation calculations or to spot-check SARABRAND results quickly for hydrocarbon-in-place estimates. Furthermore, the program should relieve the user from tedious shaly-sand calculations and allow more time for log quality control and interpretation.

49486 Relation between coal and gas show in the Chu Basin. Vlasov, V.I.; Kushev, G.L. (Academy of Sciences, Kazakh SSR). *Vestn. Akad. Nauk Kaz. SSR;* No. 9, 35-40(Sep 1978). (In Russian).

A genetic relation is established between coal and gas show in the Chu Basin that can be used to predict gas-bearing territories in the western, central and northern part of the Moinkum downwarp. The best outlook for gas recovery is in the northwest part of this region, where new gas hydrocarbon deposits may be discovered under favorable structural and lithological conditions. Early work should be concentrated on the structures of Anabay, Kashkynbay and Barkhan. 15 references, 2 figures.

49487 Deliverability predictions for northern California natural gas reserves. Bertholf, H.W. Sacramento, CA; Energy Resources Conservation and Development Commission (1978). 34p. (NP—23873).

Deliverability predictions were made for proved reserves in Northern California natural gas fields for the period 1977 to 1986. These predictions include minor amounts of gas for undeveloped reserves; they do not include additions for gas that will be discovered due to future drilling activity. Deliverability rates were predicted for (1) current contract terms, (2) 50% of demonstrated deliverability, (3) 75% of demonstrated deliverability, and (4) the maximum sustainable. For those wells whose current contract rate-of-take exceeded the category rate, the contract rate was used.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 49478

49488 (DOE/MC/05205—T1) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons. Well P-1 Sullivan County, Indiana.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 18 May 1979. Contract DE-AC21-76MC05205. 74p. P 04/MF A01.

Partial data on the characterization of shales from Well P-1 (Sullivan County, Indiana) were presented in the Fifth Quarterly Technical Progress Report on The Characterization of Devonian Shale to DOE/METC (ORO-5205). This individual well report presents and discusses the total characterization data available on P-1 shales. Coring of the shale samples were accomplished in September, 1976. A total of 17 samples were obtained: 11 for Battelle and six for other DOE contractors. P-1 well exhibited relatively high hydrocarbon gas contents compared to other wells. Average hydrocarbon gas contents surrounding the free space in the canasters is about 61 percent of the total gases (including air). Methane and ethane make up the bulk of total hydrocarbons. Chemical characterization data (carbon and hydrogen contents) relate well with the hydrocarbon gas content, as do the bulk densities among the physical characterization data.

49489 (DOE/MC/05205—T4) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons. Well C-338 Wise County, Virginia.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 15 May 1979. Contract DE-AC21-76MC05205. 45p. P 03/MF A01.

Battelle-Columbus Laboratories continues to submit Individual Well Reports on the Eastern Gas Shales Project. Results and their analyses on all six tasks are reported on the C-338 Well (Wise County, Virginia). Samples from the C-338 well were cored between depths of 4870 and 5475 feet. A total of 81 samples were obtained. Considerably high hydrocarbon gas contents are observed (average hydrocarbon gas content in the canisters was 63.1%). Higher chain hydrocarbon gases are also present in significant quantities. Average hydrocarbon gas volume per unit volume of shale is 1.2. Gas release kinetics studies on C-338 shales reveal diffusion coefficients in the order of 10^{-7} cm^2/s, which agree well with values of other shales. Excellent one-to-one correlations exist between the chemical characteristics (carbon, hydrogen contents) and hydrocarbon gas contents. Increasing carbon and hydrogen values are associated with higher hydrocarbon gas contents. Among the physical characterization data, densities are inversely related to organics contents, increasing the hydrocarbon gas contents.

MARKETING AND ECONOMICS

49490 (DOE/EIA—0176) **Buyer/seller codes.** Ryan, J.; Hirsh, M. (Department of Energy, Washington, DC (USA). Energy Information Administration; Federal Energy Regulatory Commission, Washington, DC (USA)). Apr 1979. 127p. P 07/MF A01.

The Buyer/Seller Codes in this publication are six digit code numbers assigned to buyers and sellers of natural gas for use in Federal Energy Regulatory Commission (FERC) data collection efforts. The publication is organized alphabetically by name.

49491 Conservation of natural gas. Sacramento, CA; California Energy Resource Conservation and Development Commission (1978). 117p. (NP—23861).

The conservation potential in the service area of each participant (PG and E, SCG, SDG and E) in LNG projects is reviewed. Appliance and building standards were incorporated directly in the ERCDC forecast models. Additional conservation measures were also analyzed, including retrofit of insulation, night thermostat setback, other retrofits, pool covers, etc. The aggregate energy savings over the period 1978 to 1995 would be about 26 billion therms at a cost of $1.9 billion. New savings is $8.4 billion. (DLC)

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

49492 (CONF-790805—1) **Demonstration of massive hydraulic fracturing: Piceance Basin, Rio Blanco County, Colorado.** Fitch, J.L.; Medlin, W.L.; Strubhar, M.K. (Mobil Research and Development Corp., Dallas, TX (USA)). 1979. Contract EY-76-C-08-0678. 25p. P 02/MF A01.

From DOE symposium on enhanced oil and gas recovery and improved drillings technology; Tulsa, OK, USA (22 Aug 1979).

A massive hydraulic fracturing demonstration has been conducted by Mobil and DOE in Mesaverde and overlying sands below the productive Wasatch Formation in Mobil's Piceance Creek Field. The experimental well was drilled in 1977. During that year intervals between 9500 and 10,800 ft. were tested and massive fracturing treatments were carried out in two of them, zones 1 and 3. These zones were put on production during early 1978 with gas rate declining from about 4.0 to 1.1 MMCFD during an 86-day test period. Since May, 1978, four additional massive fracturing treatments have been conducted in zones 5 and 9. Treatment size was less than planned in three of these treatments because of severe treating pressure increases during fracturing, terminated by sand-outs. This problem had occurred to a lesser degree in zones 1 and 3. However, it did not occur in the topmost interval, zone 9, where a planned treatment with 700,000 lb. of sand was put away without difficulty. This interval, identified with the Ohio Creek formation, consists of about 150 ft. of almost continuous sand and appears to be less lenticular than the Mesaverde. The zone 9 treatment was the most successful of the entire sequence. Following cleanup it was produced at an initial rate of 4.0 MMCFD and declined to 2.0 MMCFD after 50 days of production. Following this test the well was shut in to remove two isolation plugs remainingin the well between zones 8 and 9 and between zones 3 and 4. Upon completion of this work the well will be produced into a sales line with flow from all zones to obtain flow behavior data for the entire well. This paper covers details of completion and testing work done on the well since mid-

1978. Details of work done prior to that time are given in previous publications.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 50217

49493 (DOE/EIA—0177) **Small producer certificate dockets sequenced by docket number.** Ryan, J.; Hirsh, M. (Department of Energy, Washington, DC (USA). Energy Information Administration; Federal Energy Regulatory Commission, Washington, DC (USA)). Apr 1979. 376p. P 17/MF A01.

This publication lists, in numerical sequence, all small producer certificate dockets assigned by the Federal Energy Regulatory Commission (FERC) through the filing date of the last listed docket.

49494 (DOE/EIA—0178) **Small producer certificate holders and co-owners, listed alphabetically.** Ryan, J.; Hirsh, M. (Department of Energy, Washington, DC (USA). Energy Information Administration; Federal Energy Regulatory Commission, Washington, DC (USA)). Apr 1979. 401p. P 18/MF A01.

This publication lists all applicants and co-owners in small producer certificate applications filed with the Federal Energy Regulatory Commission (FERC) through February 5, 1979.

49495 (DOE/TIC—10308) **Study of future U.S. requirements for propane and butanes through 1980.** (Williams Companies, Tulsa, OK (USA)). 16 Jun 1977. 148p. P 07/MF A01.

Demand for LP gas, propane and butanes, in United States is forecast to increase moderately through 1980. Demand volumes are expected to rise from 988 thousand bbl/d during 1976 to 1,235 thousand bbl/d in 1980. Residential and commercial users consumed 53% of total propane volumes during 1976, and the increase in consumption is forecast to be moderate. The largest demand increases are expected to occur with industrial users and as petrochemical feedstocks. Industrial propane volumes are projected to expand from 63 thousand bbl/d during 1976 to 105 thousand bbl/d in 1980. Chemical propane volumes are expected to grow from 125 thousand to 200 thousand bbl/d during that time span, which would be near the peak volume of 1972 and 1973. The South and Southwest are projected to increase consumption of LP gas from 345 thousand bbl/d during 1976 to 455 by 1980, which reflects the petrochemical production within that area. Total supplies from U.S. sources are expected to decline. LP gas refinery production should increase, but not enough to offset expected decreases from U.S. gas plant production. Imports of LP gas from Canada are forecast to remain approximately static near the current levels. Overseas imports would provide volumes to satisfy unfilled market demands.

49496 (DOE/TIC—10462) **Strategic petroleum reserve and liquefied natural gas supplies. Final report.** Fink, R.J.; Bancroft, B.A.; Palmieri, T.M. (TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). 15 Feb 1977. 80p. P 05/MF A01.

The United States is planning to import liquefied natural gas (LNG) to offset the effects of our apparent dwindling natural gas supply. These imports would begin by the 1980s and would come from Algeria, Indonesia, Pakistan, Iran, Nigeria, and possibly the Soviet Union. If a disruption in LNG supplies were to occur, the impact to the nation could be eased by supplying oil to those with dual fuel (oil or gas) capability. The Strategic Petroleum Reserve (SPR) could be called upon to supply this oil if an LNG embargo were to occur simultaneously with a foreign oil embargo. To assist the Strategic Petroleum Reserve Office (SPRO) in planning the SPR, this report analyzes the impact which would be caused by an LNG embargo alone and a simultaneous LNG and oil embaro. The latter is of prime importance since incremental oil demand caused by an LNG only embargo could be met from the normal oil suppliers. Assuming a 15% industrial dual fuel capability and 0.4 trillion cubic feet LNG annual import level (likely lower limits), incremental oil demand caused by an LNG and oil embargo would be an insignificant 0.02 million barrels per day; should imports rise to 3.8 Tcf and dual fuel capability increase to 85% of gas consumption (probable upper limits) incremental oil demand could rise to 1.28 MMbbl/d which represents 39% of total demand on the SPR.

TRANSPORT, PIPELINES, AND HANDLING

49497 (DOE/TIC—10366) **National economic impact of Alaskan natural gas transportation systems. Working group report.** (Federal Energy Administration, Washington, DC (USA); Department of Commerce, Washington, DC (USA); Department of the Interior, Washington, DC (USA); Department of Labor, Washington, DC (USA)). 30 Jun 1977. 54p. P 04/MF A01.

The FPC Recommendation to the President compared the three alternative systems against two criteria, net national economic benefits and cost of service. All systems had substantial net benefits (from $5.8 billion to $8.2 billion) and a cost of service that was judged competitive with alternate fuels (a high of $2.26 per MCF). Alcan and Arctic had the highest net benefits and a lower cost of service than El Paso. This Task Force report examines the sensitivity of the FPC findings to different discount rates, cost overruns, and schedule delays and calculates new employment impacts. The new findings indicate that all of the systems still have positive net benefits ($3.3 billion to $4.8 billion) although reduced from the FPC levels and have increased costs of service (a high of $2.50 per MCF) which are still competitive with alternative fuels. Alcan has the highest benefits with El Paso second. Net benefits will be reduced to zero if any of the following occur: a construction delay greater than four years, construction cost increases of more than 100%, or a reduction in throughput from 2.4 BCFD to less than 1.2 BCFD. 22 tables.

49498 **Welding X70 Arctic Grade line pipe at frigid temperatures.** Liegeois, J.; Leclerc, J.; Bourdillon, F.; Latrance, M. (USINOR, Dunkerque, France). *Pipeline Gas J.;* vp(Sep 1978).

Cold chamber welding tests at -30°C using cellulosic electrodes showed that low-carbon, low-sulfur, cerium-treated Mn—Mo—Nb steels are not sensitive to cold cracking and that the weld heat affected zones retain good toughness. The same tests carried out with the new, improved welding electrodes would be expected to yield still better results. Similarly, good performance would also be expected when gas-shielded, automatic welding is used. Gas-shielded, automatic processes are currently being developed for welding of Arctic pipeline.

OIL SHALES AND TAR SANDS

RESERVES AND EXPLORATION

49499 (CONF-790739—2) **Case study of an application of computer mapping in oil-shale resource mapping.** Davis, F.G.F. Jr.; Smith, J.W. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). 1979. 20p. P 02/MF A01.

From Harvard computer graphics week '79; Cambridge, MA, USA (15 Jul 1979).

The Laramie Energy Technology Center, U.S. Department of Energy, is responsible for evaluating the resources of potential oil and the deposit characteristics of oil shales of the Green River Formation in Colorado, Utah, and Wyoming. While the total oil shale resource represents perhaps 2 trillion barrels of oil, only parts of this total are suitable for any particular development process. To evaluate the resource according to deposit characteristics, a computer system for making resource calculations and geological maps has been established. The system generates resource tables where the calculations have been performed over user-defined geological intervals. The system also has the capability of making area calculations and generating resource maps of geological quality. The graphics package that generates the maps uses corehole assay data and digitized map data. The generated maps may include the following features: selected drainages, towns, political boundaries, township and section surveys, and corehole locations. The maps are then generated according to user-defined scales.

SITE GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 49484

SITE GEOLOGY

REFER ALSO TO CITATION(S) 50194

49500 (DOE/MC/05205—T2) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons. Well 0-1 Christian County, Kentucky.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 25 May 1979. Contract DE-AC21-76MC05205. 39p. P 03/MF A01.

Partial data on the characterization of Well 0-1 (Christian County, Kentucky) shales were first reported in the Fifth Quarterly Technical Progress Report on January 1978. This report presents all the characterization data and its analysis on the 0-1 shales. Coring of Well 0-1 was accomplished in October 1976. A total of 17 samples were obtained, 13 for Battelle and 4 for other DOE Contractors. Methane is almost the sole hydrocarbon gas present in these shales, with higher chain hydrocarbon gases nearly nonexistent. An apparent increase in hydrocarbon gas contents with shale depth is observed. Other organic contents (in the form of carbon and hydrogen) also show an increase with increasing shale depth. An increase in hydrocarbon gas contents with carbon and hydrogen contents is also

noticeable. Natural gas, carbon and hydrogen contents all vary inversely with bulk densities. 0-1 shales show low mercury intrusion porosities and very low to negligible gas permeabilities. Lithology of these shales is very similar to those previously reported, quartz being the most abundant single mineral. Illite and kaolin are the major clay minerals with a number of carbonates (nahcolite, sortite, siderite) present in moderate quantities. Pyrite is also observed in significant quantities.

49501 (DOE/MC/05205—T3) **Characterization and analysis of Devonian shales as related to release of gaseous hydrocarbons. Well C-336 Martin County, Kentucky.** Kalyoncu, R.S.; Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 16 May 1979. Contract DE-AC21-76MC05205. 61p. P 04/MF A01.

Partial data on the characterization of C-336 (Martin County, Kentucky) shales were reported in the Sixth Quarterly Technical Progress Report, January through March 1978. Total characterization data and interpretation are presented in this Individual Well Report on shales from Well C-336 (Ky No. 3). Coring of C-336 well was accomplished in November 1976. Samples were obtained at depths from 2479 to 3371 feet. 119 samples were collected for Battelle and 90 for other DOE contractors. Shales from Well C-336 exhibit relatively high hydrocarbon gas contents. Oxygen to nitrogen ratios in the gas analysis continue to be very low, leading to various possibilities mentioned in previous reports. Wide range in carbon contents characterizes the chemical composition of the organics in these shales. Positive relationships exist between the hydrocarbon gas contents and chemical data (carbon and hydrogen). Relationships between the physical data and gas contents are not as distinct, though, an inverse relationship does exist between the bulk density and hydrocarbon gas contents.

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

49502 **Oil shale retorting: a correlation of selected infrared absorbance bands with process heating rates and oil yield.** Evans, R.A.; Campbell, J.H. (Lawrence Livermore Lab, Calif). *In Situ;* 3: No. 1, 33-51(1979).

The measured absorbance for specific infrared bands of Colorado shale oil is correlated with process oil yield and retorting rate. The results show excellent correlations using bands associated with olefinic groups (910, 990 and 1640 cm;sup -1;); analyses were carried out using both quantitative and qualitative infrared methods. No pretreatment of the crude shale oil is required. The results are encouraging enough that, with further development, the method may have potential use as an "on-line" monitoring technique for various retorting processes. 8 refs.

SURFACE METHODS

49503 **Eastern oil shale: a new resource for clean fuels.** Chicago, IL; Institute of Gas Technology ([nd]). 22p. (NP—23863).

THe Devonian shales of the Eastern US can be processed to yield more than twice as much oil as had been thought possible. The new IGT process termed HYTORT (an acronym for hydroretorting) is based on the controlled heating of the oil shale in a hydrogen atmosphere. The HYTORT Process can be used to produce oil or pipeline-quality gas. Economic analyses indicate that Devonian shales containing 10 or more weight percent organic carbon can be commercially attractive. High-grade synthetic oil can be produced from Eastern shale at a cost equal to or lower than the cost of refined shale oil produced from Western shale by conventional thermal retorting. It is estimated that the quantity of oil that could be recovered from Eastern oil shale by aboveground hydroretorting is 423 billion barrels - more than three times the total US recoverable crude oil reserves. Devonian shales can be mined along an extensive outcrop line in many Eastern states. An accelerated program is suggested that will allow design of a commercial-scale plant.

49504 (CONF-7811122—1) **IGT HYTORT process for hydrogen retorting of Devonian oil shales.** Weil, S.A.; Feldkirchner, H.L.; Punwani, D.V.; Janka, J.C. (Institute of Gas Technology, Chicago, IL (USA)). 1978. Contract W-7405-ENG-26. 37p. P 03/MF A01.

From Chattanooga shale conference; Oak Ridge, TN, USA (14 Nov 1978).

Until recently, many shales were considered unsatisfactory feedstocks because of their relatively low oil yields in the Fischer Assay test and in conventional thermal retorting. In many instances - most notably in the case of Devonian marine shales of the eastern United States - Fischer Assay oil yields, per unit weight percent of organic shale content, have been less than half of those obtained from the more familiar but less abundant Eocene lacustrine shales of the Green River area of Colorado, Utah, and Wyoming. This strongly suggests that yield differences are related to the chemistry of the specific kerogen being retorted, and in particular to its hydrogen content. IGT work has shown that elemental hydrogen can react with kerogen to enhance the yield of shale oil and hydrocarbon gases obtained by retorting. This work led to the HYTORT concept for the production of syncrude and gas. Utilizing Eastern US Devonian oil shale feedstocks, organic carbon recoveries as high as 90% have been achieved in thermobalance tests, and as high as 85% in bench-scale tests; this compares with a conversion level of only about 35% using eastern shale feedstocks and conventional retorting. Preliminary economic analyses indicate that HYTORT can produce syncrude from low-grade eastern Devonian shales competitively with TOSCO and Paraho processing of higher-grade Colorado shales.

49505 **IGT HYTORT Process for hydrogen retorting of Devonian oil shales.** Weil, S.A.; Feldkirchner, H.L; Punwani, D.V.; Janka, J.C. Chicago, IL; Institute of Gas Technology (1979). 7p. (CONF-790571—3).

From 6. national conference on energy and the environment; Pittsburgh, PA, USA (21 May 1979).

In the IGT HYTORT Process, Devonian shales are processed at controlled heating rates in an atmosphere of hydrogen at high pressure which can more than double the yields of shale oil and hydrocarbon gases. The resources of Devonian oil shale and the economics of producing synthetic crude oil from them are discussed briefly. (LK)

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 49457

49506 **Compound types and properties of Utah and Athabasca tar sand bitumens.** Bunger, J.W.; Thomas, K.P.; Dorrence, S.M. (Laramie Energy Technol Cent, Wyo). *Fuel;* 58: No. 3, 183-195(Mar 1979).

Properties and compound types were examined in detail for tar-sand bitumens representative of four major deposits in Utah and Alberta. Methods for bitumen extraction, separation, and compound type (functional group) analysis are presented. Results of the analyses are compared with each other and with results in the literature for tar-sand bitumens and petroleum. Simulated distillation and chromatographic separation data indicate that, in general, the tar-sand bitumens most closely resemble Wilmington petroleum with respect to hydrocarbon/nonhydrocarbon distribution. Tar-sand bitumens were also shown to differ significantly from one another, principally in the amounts and kinds of heteroatomic compound types present. This information is important because of the effects that composition has on recovery and refining processes. Analysis of the chemical functionalities also provide a basis for developing correlations between bitumen composition and the recovery and processing characteristics of the bitumen. 64 refs.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 50614

NUCLEAR FUELS

REFER ALSO TO CITATION(S) 50014, 50015, 50016, 50017

RESERVES

49507 (ORNL/EIS—121/V2/R1) **Geological and geochemical aspects of uranium deposits: a selected, annotated bibliography. Vol. 2, Rev. 1.** Thomas, J.M.; Brock, M.L.; Garland, P.A.; White, M.B.; Daniel, E.W. (comps.). (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 272p. P 12/MF A01.

This bibliography, a compilation of 490 references, is the second in a series compiled from the National Uranium Resource Evaluation (NURE) Bibliographic Data Base. This data base is one of six data bases created by the Ecological Sciences Information Center, Oak Ridge National Laboratory, for the Grand Junction Office of the Department of Energy. Major emphasis for this volume has been placed on uranium geology, encompassing deposition, genesis of ore deposits, and ore controls; and prospecting techniques, including geochemistry and aerial reconnaissance. The following indexes are provided to aid the user in locating references of interest: author, geographic location, quadrangle name, geoformational feature, taxonomic name, and keyword.

EXPLORATION

REFER ALSO TO CITATION(S) 49507, 50194

49508 (GJBX—76(79)) **Uranium hydrogeochemical and stream sediment reconnaissance of the Craig NTMS Quadrangle, Colorado, including concentrations of forty-three additional elements.** Bolivar, S.L.; Hill, D.E. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract EY-76-C-13-1664. 313p. (LA—7506-MS). P 14/MF A01.

A hydrogeochemical and stream sediment reconnaissance for uranium in the Craig NTMS Quadrangle, Colorado, was conducted as part of the National Uranium Resource Evaluation. Totals of 1234 water and 1732 sediment samples were collected from 1743 locations over a 18,900 km² area at an average density of one location per 11 km². Water and/or sediment samples were collected from streams and springs. All water samples were analyzed for uranium and 12 other elements. Sediment samples were analyzed for uranium, thorium, and 41 additional elements. The uranium concentrations in water samples range from below 0.02 ppB to 856.44 ppB. The recalculated mean uranium concentration for all water types is 1.55 ppB. The recalculated mean was obtained after dropping five samples with values greater than 50.00 ppB. Waters with anomalous uranium concentrations were found in tributaries of streams that drain upper Cretaceous formations southwest of Craig, north of the Williams Fork Mountains, in Middle Park, and in an area underlain by Tertiary volcanics in the southeast corner of the Craig Quadrangle. Sediment samples from the quadrangle were found to have uranium concentrations that range from 1.53 ppM to 385.60 ppM, with a recalculated mean uranium concentration for all sediments of 6.23 ppM. The recalculated mean was obtained after dropping 13 samples with values greater than 50.00 ppM. Eight areas containing clusters of sediments with anomalous uranium concentrations are delineated. The two areas containing sediment samples with the highest uranium concentrations are in the Sand Wash basin and in the Park Range northeast of Steamboat Springs. Thorium concentrations in sediment samples range from 1.10 ppM to 1596.00 ppM with a mean of 26.75 ppM. Seven areas contain clusters of samples with individual thorium concentrations greater than 70 ppM. The areas containing the highest thorium values coincide with clusters of high uranium sediment samples in the Sand Wash basin.

49509 (GJBX—77(79)) **Uranium hydrogeochemical and stream sediment reconnaissance of the Cortez NTMS Quadrangle, Colorado/Utah, including concentrations of forty-three additional elements.** Warren, R.G. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract EY-76-C-13-1664. 272p. (LA—7505-MS). P 12/MF A01.

During the summers of 1976, 1977, and 1978, 598 water and 1657 sediment samples were collected from 1775 locations within the 19,600-km² area of the Cortez Quadrangle, Colorado and Utah. Water samples were collected from streams, springs, and wells; sediment samples were collected from stream channels (wet and dry) and from springs. Each water sample was analyzed for 13 elements, and each sediment sample was analyzed for 43 elements. Uranium concentrations in water samples range from below the detection limit of 0.02 to 241.47 ppB and have a median of 0.87 ppB and a mean of 3.80 ppB. Background uranium concentrations are 2 to 5 ppB in several nonmountainous regions but are much lower in mountainous areas, particularly in the northeastern portion of the quadrangle. Water samples containing high uranium concentrations (>20 ppB) generally are associated with high conductivities, high concentrations of other metallic elements, and geologic units, such as the Mancos shale, that are unfavorable for uranium mineralization. However, four ground-water samples exhibit high uranium concentrations without concomitant high conductivities or high concentrations of other metallic elements. Two of these samples were collected from sites in the Slick Rock U—V district, and the remaining two were collected from aquifers in the Morrison formation in the southern portion of the quadrangle where large uranium deposits are not known. Water samples collected from the northwestern corner of the quadrangle uniformly exhibit background uranium values but generally contain high nickel concentrations. In this area, U—Cu (White Canyon-type) deposits are hosted primarily by the Shinarump member of the Chinle formation. Uranium concentrations in sediment samples range from 0.51 to 76.41 ppM and have a median of 2.76 ppM and a mean of 3.08 ppM. Background uranium and metallic element concentrations decrease to the southwest from the highest values in the northeastern portion of the quadrangle.

49510 (GJBX—95(79)(Vol.1)) **Aerial gamma ray and magnetic survey: Uncompahgre Uplift Project, Salina, Utah; Moab, Utah and Colorado, Montrose and Leadville, Colorado Quadrangle. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Apr 1979. Contract EY-76-C-13-1664. 86p. Dep. NTIS, PC E06/MF E06.

In the fall of 1978, an airborne reconnaissance radiometric and magnetic survey was flown by geoMetrics in western Colorado and eastern Utah as part of the Department of Energy's National Uranium Resource Evaluation program. A total of 13,390 line miles were flown in the four 1° x 2° topographic maps - Salina, Moab, Montrose and Leadville - encompassed by the survey area. The survey area includes portions of the Colorado Plateau and Southern Rocky Mountains Physiographic Provinces. A series of uplift and basin structures are distributed throughout both provinces. Thick sequences of relatively flat-lying, Phanerozoic age, sedimentary and some volcanic materials overlie crystalline basement rocks in most of the Colorado Plateau, but are relatively thin in most of the Southern Rocky Mountains. Precambrian crystalline basement rocks are exposed over some of the uplifted areas. Radioactive mineral deposits of many different types are reported. The literature consulted included information on about 1,300 occurrences of radioactive minerals and/or anomalous radioactivity within the project area. About 1,048 of these occurrences are mines which have produced or are now producing uranium. About 917 of the productive deposits are in the Moab Quadrangle, about 115 in the Salina Quadrangle and eight each in the Montrose and Leadville Quadrangles. A total of 582 grouped statistical values in the uranium window meeting the criteria established for valid anomalies are displayed and discussed in the interpretation section: 181 in Salina; 88 in Moab; 220 in Montrose; and 93 in Leadville. Some anomalies are associated with known uranium occurrences and mines such as the Uravan Belt, but most are not and are scattered across the entire range of Proterozoic and Phanerozoic rocks exposed in the survey area. Residual magnetic data generally delineate the major geologic structures present as well as providing more detailed information concerning specific rock units.

49511 (GJBX—99(79)(Vol.1)) **Aerial radiometric and magnetic survey: Corpus Christi/Laredo National Topographic Map, Texas Gulf Coast.** (Geodata International, Inc., Dallas, TX (USA)). 8 Jan 1979. Contract EY-76-C-13-1664. 158p. PCE 14/MF E14.

The results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Corpus Christi/Laredo National Topographic Map NG14-2 (Laredo) and NG14-3 (Corpus Christi) are presented in Volumes I and II of this report. The airborne data gathered are reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also.

49512 (GJBX—99(79)(Vol.2)) **Aerial radiometric and magnetic survey: Corpus Christi/Laredo National Topographic Map, Texas Gulf Coast .** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 208p. P 10/MF A01.

Volume II contains flight line profile data and statistical analysis results from the aerial radiometric and magnetic survey of the Corpus Christi/Laredo National Topographic Map area of the Texas Gulf Coast.

49513 (GJBX—105(79)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Cody Quadrangle (Wyoming). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). May 1979. Contract EY-76-C-13-1664. 97p. P 05/MF A01.

Data acquisition, production summary, data reduction, data presentation, geology, and interpretation are discussed for the Cody Quadrangle in Wyoming.

49514 (GJBX—105(79)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Cody Quadrangle (Wyoming). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). May 1979. Contract EY-76-C-13-1664. 118p. P 06/MF A01.

The histograms and the multiparameter profiles are presented with the anomaly maps and the flight path map for the Cody Quadrangle in Wyoming.

49515 (GJBX—107(79)(Vol.1)) **Aerial radiometric and magnetic survey: Dillon National Topographic Map, Idaho and Montana.** (Geodata International, Inc., Dallas, TX (USA)). 14 May 1979. Contract EY-76-C-13-1664. 192p. Dep. NTIS, PC E10/MF E10.

Results of analyses of the airborne gamma radiation and total magnetic field survey flown for the region identified as the Dillon National Topographic Map NL12-7 is presented in Volume I and II of this report. The airborne data gathered is reduced by ground computer facilities to yield profile plots of the basic uranium, thorium and potassium equivalent gamma radiation intensities, ratios of these intensities, aircraft altitude above the earth's surface, total

gamma ray and earth's magnetic field intensity, correlated as a function of geologic units. The distribution of data within each geologic unit, for all surveyed map lines and tie lines, has been calculated and is included. Two sets of profiled data for each line are included with one set displaying the above-cited data. The second set includes only flight line magnetic field, temperature, pressure, altitude data plus magnetic field data as measured at a base station. A general description of the area, including descriptions of the various geologic units and the corresponding airborne data, is included also. 8 figures, 9 tables.

49516 (GJBX—109(79)) **Hydrogeochemical and stream sediment reconnaissance of the National Uranium Resource Evaluation Program. Primarily for the Rocky Mountain states of New Mexico, Colorado, Wyoming, and Montana and the State of Alaska. Semiannual progress report, April—September 1978.** Aamodt, P.L.; Waterbury, G.R.; Bunker, M.E.; Waller, R.A. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract EY-76-C-13-1664. 23p. (LA—7720-PR). P 02/MF A01.

During this six-month period, Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) samples were collected from approximately 60,000 locations in the Rocky Mountain states and Alaska. To date, all of the LASL Rocky Mountain region has been sampled at a nominal density of one location per 10 km^2, and 65% of Alaska has been sampled at nominal densities of either one location per 23 km^2 (flatlands) or one location per 11 km^2 (mountains). Also during the report period, water samples from 13,771 locations were analyzed for uranium by fluorometry or delayed-neutron counting (DNC). Water samples from 12,993 locations were analyzed for 12 other elements by emission spectroscopy. Sediment samples from 8820 locations were analyzed for uranium and 31 other elements by combined DNC and neutron activation analysis. Sediment samples from 22,696 locations were analyzed for two additional elements by x-ray fluorescence. No data are given. Fourteen LASL reconnaissance reports, one pilot study data release, one quarterly progress report, and a manual of LASL HSSR field procedures were open filed by the Department of Energy, Grand Junction Office.

49517 (GJBX—112(79)(Vol.1)) **Aerial gamma ray and magnetic survey: Gillette Detail Project, Wyoming. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Jun 1979. Contract EY-76-C-13-1664. 68p. PC E03/MF E03.

In the middle of August, 1978, geoMetrics, Inc., collected 810 lines miles of high sensitivity airborne radiometric and magnetic data (1/4 x 1/4 mile grid) in northeast Wyoming over a small section of the Black Hills. All radiometric and magnetic data were fully reduced and interpreted by geoMetrics and are presented as two volumes (Volume I and II) in this final report. Major geologic structures within this portion of the Black Hills Uplift are the Tertiary alkaline intrusives of the topographically dominant Bear Lodge Mountains. Economic mineral deposits are not presently known, but thorium prospects do exist in the intrusives. The data were examined for anomalous uranium values and mappable geochemical subunits using the radiometric and magnetic data. Three distinct subunits were derived based on the potassium and thorium windows. Fourteen (14) groups of uranium samples qualified as anomalies based on area wide statistics. Most anomalies are associated with the Tertiary intrusives.

49518 (GJBX—112(79)(Vol.2)) **Aerial gamma ray and magnetic survey: Powder River II Project, Gillette Detail. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). Jun 1979. Contract EY-76-C-13-1664. 450p. P 19/MF A01.

The Gillette Detail area (about 90 square miles) lies at the northern end of the Black Hills in northeastern Wyoming. The Bear Lodge Mountains are the dominant topographic features in the area, with elevations as high as 6658 feet. The Black Hills Uplift in this region contains a maximum of 5000 feet of Mesozoic and Paleozoic strata overlying Precambrian crystalline basement. The dominant local geologic structure is the Bear Lodge Pluton, an alkaline igneous complex, occupying 20% of the study area. Magnetic data clearly define the main portion of the Tertiary igneous complex and some surrounding smaller intrusives. A few small, inactive thorium—rare earth prospects represent the only known mining activity in the study area. A total of 14 groups of samples in the uranium window constitute anomalies as defined in this report. The anomalies are normally associated with the intrusive bodies though some are found in adjoining sedimentary units. The largest concentration of uranium in the central portion of the large intrusive body did not show as an anomaly due to low U/T ratios caused by extremely high thorium window count rates (maximum of 1354 cps). Three geochemical units were defined on the basis of radiometric criteria set forth in Volume I of this report. The spatial distributions of these geochemical units showed varying correlations (and contrasts) with the geologic, magnetic, and topographic variations within the study area.

49519 (GJBX—113(79)(Vol.2)(FORSYTH)) **Aerial gamma ray and magnetic survey: Powder River R and D Project. Portions of the: Forsyth, Hardin, Montana Quadrangles; Sheridan, Arminto, Wyoming Quadrangles. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). May 1979. Contract EY-76-C-13-1664. 264p. P 12/MF A01.

Thick Phaneorozoic sediments (greater than 17,000 feet) fill the northwest-trending Powder River Basin, which is the dominant tectonic structure in the study area. Lower Tertiary sediments comprise over 90% of the exposed units at the surface of the Basin. Small portions of the Bighorn Uplift, Casper Arch, and Porcupine Dome occupy the western edge of the study area. Numerous small claims and prospects are found in the Pumpkin Buttes - Turnercrest District at the south end of the study area (northeastern Arminto quadrangle). No economic deposits of uranium are known to exist in the area, according to available literature. Interpretation of the radiometric data resulted in 62 statistical uranium anomalies listed for this area. Most anomalies are found in the southern half of the study area within the Tertiary Fort Union and Wasatch Formations. Some are found in Cretaceous sediments in the adjoining uplifts to the west of the Basin.

49520 (GJBX—113(79)(Vol.2)(WYO)) **Aerial gamma ray and magnetic survey: Powder River R and D Project, Arminto Detail, Wyoming. Final report.** (GeoMetrics, Inc., Sunnyvale, CA (USA)). May 1979. Contract EY-76-C-13-1664. 584p. P 25/MF A01.

The small detail area, 18 miles by 18 miles, lying near the center of the Powder River Basin, is covered entirely by sediments of the Eocene Wasatch Formation. Historically economic uranium deposits have been worked in the southeast corner of the area which includes the northern extremity of the Pumpkin Buttes district. 127 statistical uranium anomalies were generated for the study area, based on area wide statistics.

49521 (GJBX—115(79)(Vol.2)) **Aerial radiometric and magnetic survey: Little Rock National Topographic Map, Arkansas.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 182p. P 09/MF A01.

Flight line profile data and statistical analysis results from the aerial radiometric and magnetic survey of the Little Rock National Topographic Map area of Arkansas are presented in Volume 2.

49522 (GJBX—119(79)(Vol.2)) **Aerial radiometric and magnetic survey: Hamilton National Topographic Map, Idaho and Montana.** (Geodata International, Inc., Dallas, TX (USA)). 1979. Contract EY-76-C-13-1664. 162p. P 08/MF A01.

Volume II presents the flight line profile data and statistical analysis results from the aerial radiometric and magnetic survey of the Hamilton National Topographic Map area of Idaho and Montana.

49523 (GJBX—126(79)(Vol.2C)) **Aerial radiometric and magnetic reconnaissance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-C. Havre Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Jun 1979. Contract EY-76-C-13-1664. 280p. P 13/MF A01.

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Havre Quadrangle, Montana, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Resource Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 61 uranium anomalies worthy of field-checking as possible prospects. There are 28 anomalies associated with the Judith River Formation. Lignite beds in this formation may have created an environment favorable for the precipitation of uranium from uranium-rich ground waters in a regional flow system bounded by the Milk River. Source rocks for uranium in the ground water could be younger rocks with abundant volcanic ash and bentonite to the north and south of the river, and the igneous rocks of the Bearpaw Mountains in the southwest. Numerous anomalies in the Bearpaw and Claggett shales may have been caused by extensive exposures of bentonite. There are seven anomalies in the Fox Hill Sandstone or the Colorado Shale that may be indicative of uranium prospects. Six anomalies pertaining to Tertiary rocks may indicate possible uranium mineralization in veins in igneous rocks. Four of these are associated with mafic igneous rocks characterized by unusually high radiometric content. Twenty anomalies related to Quaternary units may be significant in that they may be demonstrative of uranium-rich source rocks that could host uranium mineralization.

49524 (GJBX—126(79)(Vol.2D)) **Aerial radiometric and magnetic reconnaissance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-D Choteau Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). May 1979. Contract EY-76-C-13-1664. 230p. P 11/MF A01.

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Choteau Quadrangle, Montana, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instrument:

Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Resource Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 41 uranium anomalies worthy of field-checking as possible prospects. Twenty anomalies may be caused by uranium mineralization in Precambrian quartzites, argillites, and limestones. One anomaly in particular is very strong and extends about a half mile over three geologic units. One anomaly occurring over Cambrian rocks may reflect the presence of a deposit similar to the Blind River and Rand deposits; however, it is just as likely that it is related to a shale sequence in predominantly limestone rocks. Six anomalies associated with highly faulted Paleozoic rocks along the eastern boundary of the Rocky Mountains may contain uranium mineralization in limestones, dolomites, or sandstones. Sandstone-type uranium deposits may be indicated by 10 preferred anomalies in Cretaceous sedimentary rocks in the Great Plains physiographic province on the eastern side of the quadrangle. Many anomalies in Quaternary units may reflect the existence of uranium-rich source rocks that may host uranium prospects.

49525 (GJBX—126(79)(Vol.2F)) **Aerial radiometric and magnetic reconnaissance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-F. Lewistown Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Jun 1979. Contract EY-76-C-13-1664. 264p. P 12/MF A01.

Results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Lewistown Quadrangle, Montana, are presented. Instrumentation and methods are described in Volume 1 of this final report. Statistical and geological analysis of the radiometric data revealed 58 uranium anomalies worthy of field-checking as possible prospects. One anomaly may be associated with the Cambrian Flathead Quartzite that may contain deposits similar to the Blind River and Rand uranium deposits. Three anomalies may be indicative of sandstone-type deposits in Jurassic rocks, particularly the Morrison Formation, which hosts uranium mineralization elsewhere. One of the latter anomalies is also related to rocks of the Mississippian Madison Group, and this suggests the possible presence of uranium in limestones of the Mission Canyon Formation. There are 45 anomalies related to the Cretaceous rocks. Lignite in the Hell Creek and Judith River formations and Eagle Sandstone may have caused the formation of 22 epigenetic uranium deposits. Many anomalies occur in the Bearpaw Shale and Claggett Formation. However, only five are considered significant of the remainder are expected to be caused by large amounts of radioactive bentonite or bentonitic shale. Two other Cretaceous units that may host sandstone-type deposits are the Colorado Shale and Kootenai Formation that register 16 and two anomalies respectively. Only one anomaly pertains to Tertiary rocks, and it may be indicative of vein-type deposits in the intrusives of the Judith Mountains. These rocks may also act as source rocks for deposits surrounding the Judith Mountains. Eight anomalies related only to Quaternary units may be demonstrative of uranium-rich source rocks that could host uranium mineralization.Several anomalies are located close to oil fields and may have been cause by radium-rich oil-field brines.

49526 (GJBX—126(79)(Vol.2G)) **Aerial radiometric and magnetic reconnaissance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-G. Butte Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Mar 1979. Contract EY-76-C-13-1664. 482p. Dep. NTIS, PC E09/MF E09.

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Butte Quadrangle, Montana, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Resource Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 74 anomalies worthy of field checking as possible prospects. Thirty-nine anomalies are associated with Precambrian quartzites and argillites that may contain uranium-rich veins. Other vein-type uranium prospects may be the causes of 20 preferred anomalies related to Cretaceous and Tertiary igneous rocks, particularly the eight anomalies associated with the Boulder batholith. Sandstone-type deposits may be indicated by 18 preferred anomalies in Cretaceous and Tertiary sedimentary rocks and 18 in Quaternary units. Many of those in the Quaternary may be caused by uranium-rich source rocks. Anomalies that may reflect the presence of deposits similar to the Blind River and Rand may be associated with Cambrian quartzites. Several preferred anomalies in the Butte Quadrangle may be caused by this type of deposit. One anomaly may indicate the presence of a phosphate deposit with possible by-product uranium.

49527 (GJBX—126(79)(Vol.2J)) **Aerial radiometric and magnetic reconnaisance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-J. Ritzville Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Jul 1979. Contract EY-76-C-13-1664. 242p. P 11/MF A01.

The results of a high-sensitivity, aerial, gamm-ray spectrometer and magnetometer survey of the Ritzville Quadrangle, Washington, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 48 uranium anomalies worthy of field-checking as possible prospects. The most noteworthy anomaly is in the northeast near the Midnite and Lucky Charm uranium mines in the Precambrian Togo Formation. Nine anomalies in the same area may be indicative of vein-type deposits in igneous instrusions. The majority of anomalies are associated with the Tertiary Columbia River Group, and most are thought to be attributable to uranium-rich tuffaceous volcanics in the low-uranium basalts of the Columbia River Group. Only seven are considered significant. The tuffaceous rocks could have been the source of uranium leached by weathering and precipitated in favorable environments to form nearby deposits. Numerous anomalies coincide with roads, railroads, and towns and are most likely caused by road fill or other construction material transported into those areas. The anomalies that outline a northeast-trending belt in the west may be structurally controlled and may contain uranium in pegmatites. It is also possible that they are due to exposure of tuffaceous volcanics in the basalts.

49528 (GJBX—126(79)(Vol.2K)) **Aerial radiometric and magnetic reconnaisssance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-K. Hot Springs Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Jul 1979. Contract EY-76-C-13-1664. 294p. P 13/MF A01.

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the Hot Springs Quadrangle, South Dakota, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Resource Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 132 uranium anomalies worthy of field-checking as possible prospects. The rocks in this quadrangle register eU/eTh ratios significantly higher than normal rock types. Six anomalies associated with Precambrian rocks of the Black Hills may be indicative of vein-type uranium deposits. Paleozoic rocks ranging in age from Triassic to Mississippian contain 11 anomalies that may indicate uranium prospects in limestones. Most anomalies in this quadrangle are in units that contain bentonite. Six anomalies are associated with the Cretaceous Fall River and Lakota formations, 13 with the Cretaceous Niobrara near th contact with the Pierre Shale, and 38 with the Tertiary White River Group. Sandstone-type uranium deposits may be indicated by three anomalies in Jurassic rocks and eight in the Arikaree Formation. Anomalies related to Quaternary units may indicate the presence of uranium-rich source rocks that could host uranium mineralization.

49529 (GJBX—126(79)(Vol.2L)) **Aerial radiometric and magnetic reconnaissance survey of portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington. Volume 2-L. St. Johns Quadrangle. Final report.** (Texas Instruments, Inc., Dallas (USA)). Jul 1979. Contract EY-76-C-13-1664. 256p. P 12/MF A01.

The results of a high-sensitivity, aerial, gamma-ray spectrometer and magnetometer survey of the St. Johns Quadrangle, Arizona and New Mexico, are presented. Instrumentation and methods are described in Volume 1 of this final report. This work was done by Texas Instruments Incorporated under Bendix Field Engineering Corporation Subcontract No. 78-184-L as part of the US Department of Energy National Uranium Resource Evaluation (NURE) Program. Statistical and geological analysis of the radiometric data revealed 58 uranium anomalies worthy of field-checking as possible prospects. The most noteworthy feature in the St. Johns Quadrangle is the uraniferous province associated with the Triassic Chinle Formation in the west. There are 18 anomalies that indicate the possibility of finding sandstone-type U prospects in the Chinle Formation. Two anomalies are associated with the Triassic Moenkopi Formation and one with the Jurassic Rocks of the San Rafael Group. Significant anomalies related to Cretaceous units include one in the Dakota Sandstone and four in the Mesaverde Group. Tertiary rocks may host sandstone- and vein-type deposits. Possible sandsone-type U is indicated by two anomalies in the Baca Formation and seven in the Bidahochi Formation. Those in the Bidahochi Formation may reflect the presence of local accumulations of bentonite. Ten anomalies in the Datil Formation may have been caused by vein-type deposits, but U-rich felsic volcanics are also a distinct possibility. Many anomalies associated with Quaternary volcanics may reflect vein deposits in felsic volcanics, but the felsic volcanics themselves could create false anomalies. Four anomalies are consid-

ered strongenough to be significant. Anomalies associated with Quaternary deposits may be indicative of material derived from uranium-rich units that could host mineralization. Anomalies coinciding with roads, railroads, and towns are most likely caused by construction material transported into those areas.

MINING

REFER ALSO TO CITATION(S) 49570

FEED PROCESSING

REFER ALSO TO CITATION(S) 49572, 49574

49530 (DOE/TIC—10170) **Nuclear fuel cycle information workshop: U from H_3PO_4.** Hurst, F.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 22p. P 02/MF A01.

This paper describes how phosphate fertilizers are made, how uranium is recovered, and how to detect uranium recovery operations in a phosphate plant. 10 figures. (DLC)

ENRICHMENT

49531 (KFK—2678) **Development and technical implementation of the separation nozzle process for enrichment of uranium 235.** Syllus Martins Pinto, C.; Voelcker, H.; Becker, E.W. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernverfahrenstechnik). Dec 1977. 25p. (CONF-771109—111). U 03/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

The separation nozzle process for the enrichment of uranium-235 has been developed at the Karlsruhe Nuclear Research Center as an alternative to the gaseous diffusion and centrifuge process. The separation of uranium isotopes is achieved by the deflection of a jet of uranium hexafluoride mixed with hydrogen. Since 1970, the German company of STEAG, has been involved in the technological development and commercial implementation of the nozzle process. In 1975, the Brazilian company of NUCLEBRAS, and the German company of Interatom, joined the effort. The primary objective of the common activity is the construction of a separation nozzle demonstration plant with an annual capacity of about 200 000 SWU and the development of components of a commercial plant. The paper covers the most important steps in the development and the technical implementation of the process.

LASER EXCITATION

49532 (NRCN-ms—2) **Recombination in supersonic flow in devices for laser isotope separation.** Avron, Y.; Kahane, S. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). May 1978. 20p. U 03/MF A01.

The kinetics of recombination in a weakly ionized, dilute, monoatomic gas which is adiabatically expanding into vacuum in steady supersonic flow are examined. A theoretical problem posed in laser isotope separation -the selection ionization when a fraction of the gas atoms is thermally ionized - is being treated. Numerical results for parameters corresponding to uranium are given.

BY-PRODUCTS

DEPLETED URANIUM

49533 (NUKEM—292) **Yield, utilization, storage and ultimate storage of depleted uranium.** Aumueller, L.; Hermann, J. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). Nov 1977. 94p. (In German). U 05/MF A01.

More than 80% of the uranium leaving uranium enrichment plants is depleted to a residual content of about 0,25% U 235. Due to the present ineconomical further depletion to the technically possible residual content of 0,1% U 235, the so-called 'tails' are first of all stored. The quantity of stored depleted uranium in the FRG should be about 100.000 t by the year 2000. It represents a strategic reserve for future energy supply regardless of profitableness. The study analysis the conceivable possible uses for the tails quantity considered. These are, besides further depletion whose profitableness is considered, also the use as breeder material in breeder reactors and the use in the non-nuclear field. The main part of the study deals with the various storage possibilities of the depleted uranium in oxidic or fluoride form. A comparison of costs of alternative storage concepts showed a clear advantage for the storage of UF_6 in 48 inch containers already in use. The conceivable accidents in storing are analyzed and measures to reduce the consequences are discussed. Finally, the problems of ultimate storage for the remaining waste after further depletion or use are investigated and the costs arising here are also estimated.

FUELS PRODUCTION AND PROPERTIES

49534 (INIS-mf—4502) **Compatibility of stainless steels with particles and powders of uranium carbide and low-sulphur UCS fuels.** Venter, S. (Pretoria Univ. (South Africa)). May 1978. 116p. U 06/MF A01.

Thesis.

Slightly hyperstoichiometric (U,Pu)C is a potential nuclear fuel for fast breeder reactors. The excess carbon above the stoichiometric amount results in a higher carbon activity in the fuel, and carbon is transferred to the stainless steel cladding, resulting in embrittlement of the cladding. It is with this problem of carbon transfer from the fuel to the cladding that this thesis is concerned. For practical reasons, UC and not (U,Pu)C was used as the fuel. The theory of decarburisation of carbide fuel and the carburisation of stainless steel, the facilities constructed for the project at the Atomic Energy Board, and the experimental techniques used, including preparation of the fuels, are discussed. The effect of a number of variables of uranium carbide fuel on its compatibility behaviour with stainless steels was investigated, as well as the effect om microstructure and type of stainless steel (304, 304 L and 316) on the rate of carburisation. These studies can be briefly summarised under the following headings: powder-particle size; surface oxidation of uranium carbide; preparation temperature of uranium carbide; low sulfur UCS fuels; uranium sulfide and the microstructure and type of steel. The author concludes that: the effect of surface oxidation and particle size must be taken into account when evaluating out-of-pile tests; the possible effects of surface oxidation must be taken into account when considering vibro-compacted carbide fuels; there is no advantage in replacing a fraction of the carbon atoms by sulphur atoms in slightly hyperstoichiometric carbide fuels, and the type and thermo-mechanical treatment of the stainless steel used as cladding material in a fuel pin is not important as far as the rate of carburisation by the fuel is concerned.

49535 (PNL—2973) **Thoria development activities. Annual report, fiscal year 1978.** Hart, P.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 40p. P 03/MF A01.

Pacific Northwest Laboratory's (PNL) ThO_2 development activities for FY-1978 are reviewed. These activities are in support of the FRAD (Fuels Refabrication and Development) program's goal of developing proliferation resistant fuel cycles. Included are results for the five ThO_2 fuel related elements that are assigned to PNL. During FY-1978, work on these elements has been directed primarily toward establishing the TOFDL (Thorium Oxide Fuel Development Laboratory) facility where unit operations for ThO_2-based fuels will be defined and fuels for test irradiations fabricated. Additional activities include evaluation of ThO_2 powders derived by various oxalate precipitation conditions, the fabricability of commercially available ThO_2 powders, hybrid pellet fuel fabrication and definition of an irradiation test plan.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 49549, 49550

49536 (ANL—78-68) **Chemical Engineering Division fuel cycle programs. Progress report, January—March 1978.** Steindler, M.J.; Ader, M.; Barletta, R.E. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 254p. P 12/MF A01.

Fuel cycle studies reported for this period include studies of advanced solvent extraction techniques focussed on the development of centrifugal contactors for use in Purex processes. Miniature single-stage and eight-stage centrifugal contactors are being employed in studies of contactor performance and the kinetics of extraction. A 9-cm-ID centrifugal contactor has been completed, and fabrication drawings are being prepared for a plant-scale contactor. In other work, tricaprylmethyl-ammonium nitrate and di-n-amyl n-amylphosphonate are being evaluated as extractants in the Thorex process. Literature on the dispersion of liquids by explosions is being reviewed. A process was developed for extracting TBP degradation products from TBP-Na_2CO_3 scrub solutions while the actinides remain with the raffinate. In the program on pyrochemical and dry processing of nuclear fuel, the literature is being reviewed for acceptable materials for containment vessels, decladding methods are being evaluated, salt transport processes are being studied, a candidate flow sheet (based upon the Dow Aluminum Pyrometallurgical process) for reprocessing spent uranium metal fuel was pre-

pared, work was begun on the use of molten salts for reprocessing actinide oxides, and the reprocessing of $(Th,U)O_2$ solid solution in a KCl-LiCl salt containing $ThCl_4$ and thorium chips was studied. Work on the encapsulation of solidified radioactive waste in a metal matrix includes study of (1) chemical interactions between simulated waste forms and matrix metals, (2) the leach rates of simulated encapsulated waste forms, and (3) the corrosion of candidate matrix metals and canister materials in brine solutions.Work to establish criteria for the handling of waste cladding hulls is continuing. The transport properties of nuclear waste in geologic media are being studied to estimate leaching of radionuclides from deep repositories by groundwater.

49537 (GA-A—15440) **Consolidated reprocessing program. Quarterly progress report for the period ending May 31, 1979.** (General Atomic Co., San Diego, CA (USA)). Jun 1979. Contract EY-76-C-03-0167-053. 33p. P 03/MF A01.

This publication continues the quarterly series presenting results of work performed under the Consolidated Reprocessing Program at General Atomic Company. Results of work on this program prior to June 1974 were included in a quarterly series on the HTGR Base Program. The work reported includes the development of unit processes and equipment for reprocessing of High-Temperature Gas-Cooled Reactor (HTGR) fuel, the design and development of an integrated pilot line to demonstrate the head end of HTGR reprocessing using unirradiated fuel materials, and design work in support of Hot Engineering Tests (HET). Work is also described on trade-off studies concerning the required design of facilities and equipment for the large-scale recycle of HTGR fuels in order to guide the development activities for HTGR fuel recycle.

49538 (RHO-SA—112) **Determination of a cold substitute for plutonium nitrate ($Pu(NO_3)_4$) calcination.** D'Ambrosia, J.T. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 6 Apr 1979. Contract EY-77-C-06-1030. 17p. (CONF-790666—2). P 02/MF A01.

From 34. Northwest regional meeting of the American Chemical Society; Richland, WA, USA (13 Jun 1979).

This activity researched candidate cold substitutes for $Pu(NO_3)_4$ needed to test prototype screw calciners for PuO_2 production. Cerous nitrate, ($Ce(NO_3)_3.6H_2O$), was identified as the most promising substitute. Four compounds (thorium nitrate, $Th(NO_3)_4.4H_2O$, aluminum nitrate, $Al(NO_3)_3.9H_2O$, ferric nitrate $Fe(NO_3)_3.9H_2O$), and cerous nitrate, $Ce(NO_3)_3.6H_2O$ and $Al(NO_3)_3.9H_2O$ were found tc have the desired physical decomposition properties. Thermal Gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA) of $Ce(NO_3)_3.6H_2O$ confirmed its thermal decomposition approximated that of $Pu(NO_3)_4$. 6 figures.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 49546, 50439

49539 (HEDL-TME—77-82) **Inventory and characterization of spent LWR fuel.** Funk, C.W.; Jacobson, L.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1979. Contract EY-76-C-14-2170. 77p. P 05/MF A01.

Spent light water reactor (LWR) fuel discharged from reactors and stored in water basins has been inventoried through 1976. Defective fuel has been defined and categorized, and the trends of failed fuel have been evaluated for their impact on the operation of receiving facilities. Failure mechanisms that release radioactivity have been identified. The sources and levels of activity have been estimated for typical LWR spent fuel assemblies.

49540 (JPRS—73720) **Translations on Eastern Europe. Scientific Affairs, No. 633.** 19 Jun 1979. Translation of various articles. 34p. C .

49541 (SAN—1583-2) **Global Spent Fuel Logistics Systems Study (GSFLS). Volume 2. GSFLS visit findings and evaluations. Interim report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). 31 Jan 1978. Contract EN-77-C-03-1583. 507p. P 22/MF A01.

This report is a part of the interim report documentation for the Global Spent Fuel Logistics System (GSFLS) study. This report describes a global framework that evaluates spent fuel disposition requirements, influencing factors and strategies. A broad sampling of foreign governmental officials, electric utility spokesmen and nuclear power industry officials responsible for GSFLS policies, plans and programs were surveyed as to their views with respect to national and international GSFLS related considerations. The results of these GSFLS visit findings are presented herein. These findings were then evaluated in terms of technical, institutional and legal/regulatory implications. The GSFLS evaluations, in conjunction with perceived US spent fuel objectives, formed the basis for selecting a set of GSFLS strategies which are reported herein.

49542 (SAN—1583-2A) **Global Spent Fuel Logistics Systems Study (GSFLS). Volume 2A. GSFLS visit findings (appendix). Interim report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). 31 Jan 1978. Contract EN-77-C-03-1583. 500p. P 21/MF A01.

This appendix is a part of the interim report documentation for the Global Spent Fuel Logistics System (GSFLS) study. This appendix provides the legal/regulatory reference material, supportive of Volume 2 - GSFLS Visit Finding and Evaluations; and certain background material on British Nuclear Fuel Limited (BNFL).

49543 (SAN—1583-3) **Global Spent Fuel Logistics Systems Study (GSFLS). Volume 3. GSFLS technical and financial analysis. Interim report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). 31 Jan 1978. Contract EN-77-C-03-1583. 340p. P 15/MF A01.

This report is a part of the interim report documentation for the Global Spent Fuel Logistics System (GSFLS) study. The technical and financial considerations underlying a global spent fuel logistics systems have been studied and are reported herein. The Pacific Basin is used as a model throughout this report; however the stated methodology and, in many cases, considerations and conclusions are applicable to other global regions. Spent fuel discharge profiles for Pacific Basin Countries were used to determine the technical systems requirements for alternative concepts. Functional analyses and flows were generated to define both system design requirements and logistics parameters. A technology review was made to ascertain the state-of-the-art of relevant GSFLS technical systems. Modular GSFLS facility designs were developed using the information generated from the functional analysis and technology review. The modular facility designs were used as a basis for siting and cost estimates for various GSFLS alternatives. Various GSFLS concepts were analyzed from a financial and economic perspective in order to provide total concepts costs and ascertain financial and economic sensitivities to key GSFLS variations. Results of the study include quantification of GSFLS facility and hardware requirements; drawings of relevant GSFLS facility designs; system cost estimates; financial reports - including user service charges; and comparative analyses of various GSFLS alternatives.

49544 (SAN—1583-3(App.A,B)) **Global Spent Fuel Logistics Systems Study (GSFLS). Volume 3A. GSFLS technical analysis (appendix). Interim report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). 31 Jan 1978. Contract EN-77-C-03-1583. 293p. P 13/MF A01.

This report is a part of the interim report documentation for the Global Spent Fuel Logistics System (GSFLS) study. The technical and financial considerations underlying a global spent fuel logistics systems have been studied and are reported. The Pacific Basin is used as a model throughout this report; however the stated methodology and, in many cases, considerations and conclusions are applicable to other global regions. Spent fuel discharge profiles for Pacific Basin Countries were used to determine the technical systems requirements for alternative concepts. Functional analyses and flows were generated to define both system design requirements and logistics parameters. A technology review was made to ascertain the state-of-the-art of relevant GSFLS technical systems. Modular GSFLS facility designs were developed using the information generated from the functional analysis and technology review. The modular facility designs were used as a basis for siting and cost estimates for various GSFLS alternatives. Various GSFLS concepts were analyzed from a financial and economic perspective in order to provide total concepts costs and ascertain financial and economic sensitivities to key GSFLS variations. Results of the study include quantification of GSFLS facility and hardware requirements; drawings of relevant GSFLS facility designs; system cost estimates; financial reports - including user service charges; and comparative analyses of various GSFLS alternatives.

49545 (SAN—1583-4) **Global Spent Fuel Logistics Systems Study (GSFLS). Volume 4. Pacific basin spent fuel logistics system.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). Jun 1978. Contract EN-77-C-03-1583. 178p. P 09/MF A01.

This report summarizes the conceptual framework for a Pacific Basin Spent Fuel Logistics System (PBSFLS); and preliminarily describes programatic steps that might be taken to implement such a system. The PBSFLS concept is described in terms of its technical and institutional components. The preferred PBSFLS concept embodies the rationale of emplacing a fuel cycle system which can adjust to the technical and institutional non-proliferation solutions as they are developed and accepted by nations. The concept is structured on the basis of initially implementing a regional spent fuel storage and transportation system which can technically and institutionally accommodate downstream needs for energy recovery and long-term waste management solutions.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 50636

49546 (NVO—196-10) **Nevada nuclear waste storage investigations. Quarterly report, January—March 1979.** (Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). May 1979. 53p. P 04/MF A01.

The processing of weapons test ground motion acceleration data for Pahute Mesa events is 86% complete. The geology, hydrology, and geophysics of drill holes UE25a # 1 and UE25a # 3 were completed as draft reports. Preliminary analysis of the Calico Hills gravity data shows that the anomalous mass is coincident with the principal body producing the magnetic anomoly (inferred to be the intrusive at depth). Mapping of Quaternary deposits has been completed for the Calico Hills-Northern Jackass Flats area. Forty-one seismograph stations have been installed as part of the Southern Great Basin seismograph network. A fission track age of about 6 m.y. was obtained on zircon from a sample of rhyolitic lump pumice collected from beneath the basalt in southeastern Crater Flat. Power was turned off to the Eleana near-surface experiment. The heater and instrumentation system design for the tuff in-stu test was completed. Batch sorption measurements on Yiucca Mountain cores were highly favorable for the isotopes studied: ^{85}Sr, ^{137}Cs, ^{133}Ce, and ^{152}Eu. Petrological characterization of core samples from the Yucca Mountain drill hole was completed. Mining of the heater drifts and the railcar room was completed for the spent fuel test: Climax. Final design reviews for the spent fuel test handling system and canister, liners, shield plug, and electrical simulators were held.

49547 (PNL—2378-4) **Nuclear waste management quarterly progress report, October—December 1978.** Platt, A.M.; Powell, J.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 65p. P 04/MF A01.

The status of the following studies is given: decontamination and densification of chop-leach cladding residues; monitoring methods for particulate and gaseous effluents from waste solidification processes; TRU waste immobilization; krypton sodidification; carbon-14 and iodine-129 fixation; waste management system; waste management safety; waste isolation safety assessment; well-logging instrumentation development for shallow land burial; monitoring and physical characterization of unsaturated zone transport; detection and characterization of mobile organic complexes of fission products; and electropolishing for surface decontamination of metals. (LK)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 49536

49548 (CONF-790420—22) **FUETAP (formed under elevated temperatures and pressures) concretes as hosts for radioactive wastes.** Moore, J.G.; Rogers, G.C.; Paehler, J.H.; Devaney, H.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 14p. P 02/MF A01.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

Cementitious solids formed at ≦ 250°C and ≦ 1000 psi offer excellent possibilities as hosts for radioactive wastes. Preliminary results are presented on the effect of mix composition, temperatre, and pressure on the physical properties of the resulting solids. Initial leach results are encouraging in the assessment of the ability of these FUETAP concretes to isolate radionuclides from the environment.

49549 (ETR—294) **Minerva process. A versatile process for the solidification of liquid wastes from nuclear fuel reprocessing.** Detilleux, E.; Eschrich, H.; van Geel, J. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jul 1978. 27p. U 03/MF A01.

The objective of the work presented in this paper is to develop an advanced technology for the conversion of the highly radiactive liquid wastes from fuel reprocessing into solid products of properties ensuring the safe isolation of the contained radionuclides from the biosphere. In pursuing this objective, the chemical and technical investigations led to the development of a process, called MINERVA, which was demonstrated in cold laboratory scale tests to be applicable not only to the solidification of various types of liquid high-level waste but also to all kinds of liquid aqueous medium-level and organic wastes generated in a Purex reprocessing plant. The Minerva process is carried out in two main operation steps: the solidification of the different waste solutions, either individually or mixed, to mineral-like granular phosphate compounds at about 500 deg C using a stirred-bed reactor; and the conditioning of the granulates according to their chemical composition and generated specific heat into either a monlithic phosphate glass-ceramic block by using the in-can melting technique, or by incorporating them into a metal matrix.

49550 (ETR—295) **Activity report 1977.** Delande, E.; Drent, W. (eds.). (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jul 1978. 60p. U 04/MF A01.

The principal activities of Eurochemic plant in the fields of reprocessing and the solidification and conditioning of liquid wastes are presented in this report that covers the period 1 January to 31 December 1977. Works in the plant are closely related to the handling of fuel element and the treatment of solid wastes as well as the management of liquid wastes. Industrial development activities have been primarily devoted to the solidification of HEWC (highly enriched waste concentrate) by means of the Lotes process; the treatment of spent solvent by means of the Eurowatt process; the treatment of the plutonium-bearing solid wastes by the Eurowetcomb process and the conditioning of highly activity non-combustible solid wastes by incorporation into polymer-concrete matrix .

49551 (KFK—2633) **Treatment of low and intermediate level wastes.** Hoehlein, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Abt. Dekontaminationsbetriebe). May 1978. 17p. U 03/MF A01.

The methods described of low and intermediate level waste treatment are based exclusively on operating experience gathered with the KfK facilities for waste management, the Karlsruhe Reprocessing Plant (WAK), the ALKEM fuel element fabrication plant, the MZFR, KNK and FR 2 reactors as well as at the Karlsruhe Nuclear Research Center and at the state collecting depot of Baden-Wuerttemberg. The processing capacities and technical status are similar to that in 1976. With an annual throughput of 10000 m^3 of solid and liquid raw wastes, an aggregate activity of 85000 Ci, 500 kg of U and 2 kg of Pu, final waste in the amount of 500 m^3 was produced which was stored in the ASSE II salt mine.

49552 (NUREG/CR—0895) **Solidification of high-level radioactive wastes. Final report.** (National Academy of Sciences - National Research Council, Washington, DC (USA). Committee on Radioactive Waste Management). Jun 1979. 261p. C .

A panel on waste solidification was formed at the request of the Nuclear Regulatory Commission to study the scientific and technological problems associated with the conversion of liquid and semiliquid high-level radioactive wastes into a stable form suitable for transportation and disposition. Conclusions reached and recommendations made are as follows. Many solid forms described in this report could meet standards as stringent as those currently applied to the handling, storage, and transportation of spent fuel assemblies. Solid waste forms should be selected only in the context of the total radioactive waste management system. Many solid forms are likely to be satisfactory for use in an appropriately designed system, The current United States policy of deferring the reprocessing of commercial reactor fuel provides additional time for R and D solidification technology for this class of wastes. Defense wastes which are relatively low in radioactivity and thermal power density can best be solidified by low-temperature processes. For solidification of fresh commercial wastes that are high in specific activity and thermal power density, the Panel recommends that, in addition to glass, the use of fully-crystalline ceramics and metal-matrix forms be actively considered. Preliminary analysis of the characteristics of spent fuel pins indicates that they may be eligible for consideration as a waste form. Because the differences in potential health hazards to the public resulting from the use of various solid form and disposal options are likely to be small, the Panel concludes that cost, reliability, and health hazards to operating personnel will be major considerations in choosing among the options that can meet safety requiremens. The Panel recommends that responsibility for all radioactive waste management operations (including solidification R and D) should be centralized. (LK)

49553 (RFP—2863) **Waste incineration and immobilization for nuclear facilities. Status report, October 1977—March 1978.** Johnson, A.J.; Burkhardt, S.C.; Ledford, J.A.; Williams, P.M. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). 17 May 1979. Contract EY-76-C-04-3533. 18p. P 02/MF A01.

Fluidized bed incineration and processes for immobilization of wastes generated at nuclear facilities are undergoing development. After minor piping modifications to eliminate dust collecting points, a pilot plant fluidized bed incinerator run of 225 continuous hours was successfully completed in a demonstration of component reliability. Vitrification of incinerator ash and other wastes is now being accomplished using a pilot scale unit developed as a continuous flow process.

49554 **Calcination process for radioactive waste.** Kilian, D.C. (to Energy Research and Development Administration, Washington, DC (USA)). Australian Patent 489,551/B/. 9 Dec 1977. 14p.

The present invention provides a method for minimizing the volatilization of chlorides during solidification in a fluidized-bed calciner of liquids containing sodium, nitrate and chloride ions. Zirconium and fluoride are introduced into the liquid, and one-half mole of calcium nitrate is added per mole of fluoride present in the liquid mixture. The mixture is calcined in the fluidized-bed calciner

at about 500 degrees C., producing a high bulk density calcine product containing the chloride, thus tying up the chloride in the solid product and minimizing chloride volatilization.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 49541, 49543, 49544, 49545, 49573, 50417, 50635, 50638

49555 (CONF-790711—3) **Shallow land burial: experience and developments at Oak Ridge National Laboratory.** Tamura, T.; Cerling, T.E.; Eyman, L.D.; Huff, D.D.; Spalding, B.P.; Stueber, A.M.; Ward, D.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. P 02/MF A01.

From International symposium on underground disposal of radioactive wastes; Otaniemi, Finland (2 Jul 1979).

At ORNL both liquid and solid wastes have been disposed of in the local Conasauga shale formation since 1943. ^{90}Sr is being released to White Oak Creek from the disposal areas. The hydrology and geology of the disposal sites are being studied. Field studies are being conducted to reduce infiltration of rain into the solid waste trenches. (DLC)

49556 (ECN—42) **Temperature calculations on different configurations for disposal of high-level reprocessing waste in a salt dome model.** Hamstra, J.; Kevenaar, J.W.A.M. (Stichting Energieonderzoek Centrum Nederland, Petten). Jun 1978. 57p. U 04/MF A01.

A medium size salt dome is considered as a structure in which a repository can be located for all radioactive wastes to be produced within the scope of a postulated nuclear power program. A dominating design factor for the lay-out of such a waste repository is the temperature distribution in the salt dome resulting from decay heat released from the buried solidified high-level reprocessing waste. Two numerical models are presented for the calculation of both global and local rock salt temperatures. The results of calculations performed with these models are demonstrated to be compatible. Rock salt temperatures related to several types of burial configurations, ranging from two layer configurations with various vertical distances between the layers via a three and a four layer repository to deep bore hole concepts varying from 100 to 600 m bore hole depth, can therefore be calculated with one rather simple unit cell model. The results of these calculations indicate that rock salt temperatures can be kept within acceptable limits to realize a repository using standard mining techniques. The temperatures at mine galery level prove to be a dominating factor in the selection of a repository configuration. More detailed calculations of these temperatures taking into account the loading sequence and the cooling capacity of the mine ventilation are recommended. Finally the apparent advantages of a deep bore hole concept emphasize the need for R and D work with respect to advanced drilling techniques in order to achieve deep dry disposal bore holes that can be realized from a burial mine in the salt dome.

49557 (ICP—1186) **Sampling of stored high-level radioactive calcined waste at ICPP.** Westra, A.G.; Schofield, J.S.; Horn, S.J.; Hendricks, J.A.; Pomiak, G.S. (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office; Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 45p. P 03/MF A01.

Equipment and procedures used to sample calcined solids stored in underground bins at the Idaho Chemical Processing Plant are described. The calcine sampling process basically consisted of driving a string of sample tubes into a calcine storage bin with a soil sampling drill rig, and withdrawing the sample tubes one at a time into a shielded sample cask located directly over the open calcine retrieval riser. Samples of both alumina and zirconia calcine were obtained and indicate that the calcine can be retrieved with a pneumatic retrieval nozzle.

49558 (ONWI—9(1)) **Office of Nuclear Waste Isolation. Technical progress report for the quarter, October 1—December 31, 1978.** (Battelle Memorial Inst., Columbus, OH (USA)). 1979. Contract EY-76-C-06-1830. 274p. P 12/MF A01.

Progress is reported in the following areas: science and technology, process/equipment development, systems analysis, site identification, facilities engineering, and site and repository licensing. (DLC)

49559 (ONWI—17) **Geochemical constraints on accumulation of actinide critical masses from stored nuclear waste in natural rock repositories. Technical report, April 1, 1978—August 31, 1978 (plus supplemental time to December 31, 1978).** Brookins, D.G. (Brookins (Douglas G.), Albuquerque, NM (USA)). 31 Dec 1978. Contract EY-76-C-06-1830. 75p. P 04/MF A01.

Results of a literature search of abundant data on lanthanide and actinide individual and joint systematics are presented. Covered were several papers/reports about uranium solution chemistry, uranium deposits, a natural fission reactor, rare-earch deposits, manganese nodules, bedded and dome salt deposits, and miscellaneous items. This literature search is not complete but represents efforts of seven individuals attempting to gather data relevant to the objectives defined in this report. Many foreign articles, as well as many English language articles are absent. Approximately 800 articles were inspected; 69 are included in the References cited. The data search for actinides and lanthanides in natural rocks indicated that only limited segregation of the actinides U, Np, Pu, Am, and Cm from the lanthanides is possible should high-level waste be released from canisters stored in various geomedia. Supporting this were studies of Oklo and other uranium deposits, manganese nodules, monomineralic and concretion formation rates, and actinide and lathanide transport in brines. The fact that some waste canisters may, under certain conditions, contain several critical masses of one or more actinides is countered by the facts that (a) most actinides have very short half-lives and would decay before release from canisters, (b) released actinides and lanthanides, although dispersed, would be transported and deposited as a group, thus preventing point concentration of any actinides, and (c) ^{235}U has a much longer half-life than the other actinides, thus allowing greater time for possible reaccumulation and criticality; such a scenario would demand that ^{235}U be segregated effectively from other elements in the lanthanide-actinide groups.No mechanism to do this is consistent with the natural occurrences studied or the theoretical Eh-pH diagrams considered.

49560 (PNL—2658) **Characterization of the Hanford 300 Area Burial Grounds. Task II. Geochemical analysis.** Ames, L.L.; Phillips, S.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-06-1830. 68p. P 04/MF A01.

The geochemical interaction of radionuclides with geologic materials must be understood in order to assess radionuclide migration from waste burial structures. In Task II, Geochemical Analysis, soil samples were taken from a representative disposal site to provide information that could be applied to the retired 300 Area Burial Grounds on the Department of Energy's Hanford Site, Washington. The site chosen for evaluation was the 316-4 Crib, which received liquid waste containing hexone and a total of 939 kg of uranium between 1948 and 1956. The methodology developed to analyze the soil samples combined neutron-enhanced autoradiography, x-ray fluorescence, and electron microprobe and radiochemical data. Results showed that the uranium content of the soil immediately underlying the crib is small. Furthermore, the uranium in the 316-4 Crib generally formed an insoluble phosphorus compound that was not readily leached under ambient conditions. However, uranium was easily leached in dilute acid solutions. Consequently, acidic solutions should not be added to waste burial structures that contain uranium compounds. The buffering and cation exchange capacity of the soil clay fraction tends to retard migration of the water-soluble forms, and uranium from the 316-4 Crib has not been detected in the Columbia River. No significant health hazard is apparent at present as a result ofuranium disposal at the 316-4 Crib; however, efforts should continue to restrict access to this site.

49561 (PNL—2879) **Entrapment of krypton in sputter deposited metals: a storage medium for radioactive gases.** Tingey, G.L.; McClanahan, E.D.; Bayne, M.A.; Moss, R.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 37p. P 03/MF A01.

Sputter deposition of metals with a negative substrate bias results in a deposit containing relatively large concentrations of the sputtering gas. This phenomenon has been applied as a technique for storage of the radioactive gas, ^{85}Kr, which is generated in nuclear fuels for power production. Alloys which sputter to yield an amorphous product have been shown to contain up to 12 atom % Kr [42 cm^3 of Kr(STP)/g of deposit; concentration equivalent to a gas at 4380 psi pressure]. Release from these metals occurs at so low a rate that extrapolation to long times yields a ^{85}Kr release at 300°C of about 0.06% in 100 years. A preliminary evaluation of the engineering feasibility and economics of the sputtering process indicates that ^{85}Kr can be effectively trapped in a solid matrix with currently available techniques on a scale required for handling DOE-generated waste or commercial reprocessed fuels and that the cost should not be a limiting factor.

49562 (RHO-C—18) **Hanford groundwater modeling: statistical methods for evaluatig uncertainty and assessing sampling effectiveness.** McLaughlin, D.B. (Resource Management Associates, Lafayette, CA (USA)). Jan 1979. Contract EY-77-C-06-1030. 93p. (RMA—8310). P 05/MF A01.

This report is the first in a series of three documents which address the role of uncertainty in the Rockwell Hanford Operations groundwater model development and application program at Hanford Site. Groundwater data collection activities at Hanford are reviewed as they relate to Rockwell groundwater modeling. Methods of applying statistical and probability theory in quantifying the propagation of uncertainty from field measurements to model predictions are discussed. It is shown that measures of model accuracy or uncertainty provided by a statistical analysis can be useful in guiding model development and sampling network design. Recom-

mendations are presented in the areas of model input data needs, parameter estimation data needs, and model verification and variance estimation data needs. 8 figures.

49563 (RHO-LD—78) **Thermal analysis of Hanford defense waste strontium and cesium capsules isolated in basalt.** Kaser, J.D. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jun 1979. Contract EY-77-C-06-1030. 33p. P 03/MF A01.

Temperatures were calculated for cesium and strontium capsules packaged in steel canisters and isolated in deep basalt formation using the HEATING5 program. For the base case with an initial heat generation rate of 5 kW per canister, the maximum temperature reached at the borehole surface is 760°F, while the canister surface reaches 845°F and the capsule surface reaches 1155°F. A sensitivity analysis showed that the temperature was most affected by changes in capsule power, basalt thermal conductivity, surface emissivity, and borehole diameter. Temperature was much less affected by changes in density and heat capacity of the basalt. Tunnel dimensions, minor changes in canister spacing or pitch had little effect. The discretization error of the numerical calculations is about 30°F. 26 figures.

49564 (RHO-LD—78-24-1Q) **Summary of radioactive solid waste burials in the 200 areas during the first quarter of 1978.** Anderson, J.D.; Poremba, B.E. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). 22 May 1978. Contract EY-77-C-06-1030. 42p. P 03/MF A01.

This document is issued quarterly for the purpose of summarizing the amount of radioactive materials that have been buried in the burial grounds. In addition to data for 1978, cumulative data since plant startup are presented. Also in this document is a listing of decayed activity to the various plant burial sites.

49565 (RHO-SA—83) **Iodide and iodate sodalites for the long-term storage of iodine-129.** Strachan, D.M.; Babad, H. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Apr 1979. Contract EY-77-C-06-1030. 18p. (CONF-790420—21). P 02/MF A01.

From International symposium on ceramics in nuclear waste management; Cincinnati, OH, USA (30 Apr 1979).

There exists several proposals for the storage of ^{129}I. None of these proposes the use of a mineral with demonstrated geologic stability. The work described in this paper identified the minerals iodide and iodate sodalites $[Na_8(AlSiO_4)_6I_2/(IO_3)_2]$ as good candidates for the long-term storage of ^{129}I.

49566 (SAND—79-0362) **Early in-situ measurements program for the Waste Isolation Pilot Plant.** Wowak, W.E. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract EY-76-C-04-0789. 49p. P 03/MF A01.

The technical basis and description of measurements for the early in-situ measurements program at the WIPP are described and a proposed organizational structure is presented. Measurements are needed for verification of design predictions and also for a prelude to the main experiment program. The design verification measurements will be concentrated in the first shaft and the underground support and access areas. Early experiments will be concentrated in the test drifts on the storage horizons. Recommendations are made to DOE for appropriate division of responsibility among Bechtel, the technical support contractor, the instrumentation contractor, and Sandia.

49567 (UCID—17858) **Suggested technical scheme to help resolve regulatory issues.** Harvey, T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1978. Contract W-7405-ENG-48. 30p. P 03/MF A01.

A management-planning model envisioned as a useful tool for planning and guiding the development of a nuclear waste repository data base is described. It incorporates the technical assessment goals and objectives of the US Nuclear Regulatory Commission, and it provides a strategy for reaching them. The model strategy includes provisions for the breadth, timeliness, and defensibility of its predictions. Consideration is given to observational data, its structure, and future refinements. The structure of the data is consistent with the needs of a systems model whose structure is proposed to resolve questions about repository safety. Uncertainties are categorized as an aid in defining and resolving technical issues. The model provides a framework for ultimately exposing all the sensitive and controversial factors. Some quantitative aspects of data acquisition are presented. 12 figures.

49568 (UCRL—15040) **Finite medium Green's function solutions to nuclide transport in porous media.** Oston, S.G. (Analytic Sciences Corp., Reading, MA (USA)). 18 Apr 1979. Contract W-7405-ENG-48. 53p. (TR—1485-2). P 04/MF A01.

Current analytical techniques for predicting the transport of nuclides in porous materials center on the Green's function approach - i.e., determining the response characteristics of a geologic pathway to an impulse function input. To data, the analyses all have set the boundary conditions needed to solve the 1-D transport equation as though each pathway were infinite in length. The purpose of this work is to critically examine the effect that this infinite pathway assumption has on Green's function models of nuclide transport in porous media. The work described herein has directly attacked the more difficult problem of obtaining suitable Green's functions for finite pathways whose dimensions, in fact, may not be much greater than the diffusion length. Two different finite media Green's functions describing the nuclide mass flux have been determined, depending on whether the pathway is terminated by a high or a low flow resistance at the outlet end. Pulse shapes and peak amplitudes have been computed for each Green's function over a wide range of geohydrologic parameters. These results have been compared to both infinite and semi-infinite medium solutions. It was found that predicted pulse shapes are quite sensitive to selection of a Green's function model for short pathways only. For long pathways all models tend toward a symmetric Gaussian flux-time history at the outlet. Thus, the results of our previous waste transport studies using the infinite pathway assumption are still generally valid because they always included at least one long pathway. It was also found that finite medium models offer some unique computational advantages for evaluating nuclide transport in a series of connecting pathways.

49569 (UCRL—82174) **Rock-melt approach to nuclear waste disposal in geological media.** Cohen, J.J.; Steinborn, T.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1979. Contract W-7405-ENG-48. 5p. (CONF-781250—1). P 02/MF A01.

From Science underlying waste management conference; Boston, MA, USA (1 Dec 1978).

An unconventional method for geologic disposal of nuclear waste has been proposed. This is the rock-melt concept which calls for the direct addition of high level waste either in solution or slurry form into a deep mined cavity in silicate rock. Following the period of waste addition, the cavity is allowed to boil dry. Subsequently, the decay heat melts the waste and the surrounding rock. The molten rock dissolves the waste and the molten mixture grows, reaching its maximum radius in tens to hundreds of years. When the rate of conductive heat loss from the system exceeds that of heat input from radioactive decay, the system begins to cool and solidify. Total resolidification could require several centuries. During the period, fission products will have essentially decayed away, leaving the actinide components. The ultimate result would be the encapsulation of this radioactive material in a relatively insoluble rock matrix deep underground.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 49555, 49568, 50580, 50602

49570 (NUREG/CR—0597) **Descriptions of United States uranium resource areas: a supplement to the generic environmental impact statement on uranium milling.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 273p. (ANL/ES—75). P 12/MF A01.

Descriptive material on six uranium-producing regions of the United States is presented in this document. The six regions include parts or all of the physiographic provinces commonly designated as the Northern Rocky Mountains, the Western Great Plains, the Wyoming Basin, the Southern Rocky Mountains, the Colorado Palteau, and the Texas Coastal Plains. The document includes chapters on climate, topography, land resources and uses, geology and seismicity, mineral resources and uses, surface water resources and uses, groundwater resources and uses, soils, terrestrial biota, aquatic biota, demographic and economic profiles, social and cultural patterns, archeology and prehistory, esthetic and recreational resources, and radiological backgrounds. Lists of threatened, endangered, and rare species and a glossary of some technical terms used are presented in appendices.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 49552, 49559, 49560

49571 (DOE/EV—0005/3(Rev.)) **Formerly utilized MED/AEC Sites Remedial Action Program. Radiological survey of the former VITRO Rare Metals Plant, Canonsburg, Pennsylvania. Final report.** (Department of Energy, Oak Ridge, TN (USA). Oak Ridge Operations Office). Jun 1979. Contract W-7405-ENG-26. 296p. P 13/MF A01.

This 18-acre site was used from 1911 to 1922 to extract radium from carnotite ore, from 1930 to 1942 to extract radium and uranium salts from onsite residues and carnotite ore, and from 1942 to 1957 to recover uranium from various ores and scrap materials. The radiological survey was conducted in two phases. Phase I

included measurement of radon and radon daughter concentrations in onsite buildings; concentrations measured in this part of the survey were all above guideline levels. Phase II consisted of measurement of surface contamination levels on the site, external gamma radiation levels at 1 m above surfaces on and near the site, radionuclide concentrations in surface and subsurface soil and water on and near the site, and radon concentrations in air at offsite locations. The results of the second phase of the survey indicate that large quantities of the radioactive wastes generated during radium and uranium recovery operations still remain on the site. Radium-bearing wastes are present in soil beneath or adjacent to each of the buildings on the site and in the top few feet of soil over almost the entire site, with some areas being contaminated to a depth of 16 ft or more. Alpha contamination levels, beta—gamma dose rates, and external gamma radiation levels in some areas of the buildings and outdoors on the site are above current federal guidelines concerning the release of property for unrestricted use. Concentrations of ^{226}Ra in water in holes drilled on the site are above the maximum permissible concentration (MPC/sub w/). Also, measurements made offsite show that contamination from the site has spread to nearby offsite locations, and that there is significant atmospheric transport of ^{222}Rn from the site.

49572 (ORNL/TM—6677) **Integrated assessmet of the impacts associated with uranium mining and milling.** Parzyck, D.C.; Baes, C.F. III; Berry, L.G. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 166p. P 08/MF A01.

The occupational health and safety impacts are assessed for domestic underground mining, open pit mining, and milling. Public health impacts are calculated for a population of 53,000 located within 88 km (55 miles) of a typical southwestern uranium mill. The collective annual dose would be 6.5 man-lung rem/year, 89% of which is from ^{222}Rn emitted from mill tailings. The dose to the United States population is estimated to be 6×10^4 man-lung rem from combined mining and milling operations. This may be compared with 5.7×10^5 man-lung rem from domestic use of natural gas and 4.4×10^7 man-lung rem from building interiors. Unavoidable adverse environmental impacts appear to be severe in a 250 ha area surrounding a mill site but negligible in the entire potentially impacted area (500,000 ha). The contemporary uranium resource and supply industry and its institutional settings are described in relation to the socio-economic impacts likely to emerge from high levels of uranium mining and milling. Radon and radon daughter monitoring techniques associated with uranium mining and milling are discussed.

49573 (TREE—1356) **Fire test of DOT 7A Boxes.** Jensen, J.D. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 61p. P 04/MF A01.

The primary objective of conducting the full-scale fire tests of the DOT (Department of Transportation) 7A FRP Boxes was to provide information to assist in quantifying the fire hazard of the storage located at the Radioactive Waste Management Complex (RWMC), and to learn if changing the storage array will decrease the fire risk. Also, the level of fire fighting and fire protection required to maintain the risk at the RWMC within acceptable DOE guidelines was investigated. Two full-scale fire tests were conducted at Southwest Research Institute (SwRI) in June 1978, using the DOE 7A FRP Plywood Storage Containers. The fire tests showed that when subjected to a substantial ignition source, the boxes will propagate fire as long as no fire-suppression measures are taken. Fire will breach the boxes and spread the radioactive contaminated waste if it is not extinguished. As the fire progresses, additional boxes will become involved, and eventually the entire storage array will ignite. It is recommended that the use of DOT 7A Boxes be discontinued and replaced with noncombustible storage containers. In the event this is not practicable, guidance recommendations are presented to minimize the large fire loss potential. It is also recommended that an investigation be conducted into the number of boxes that can be destroyed and still maintain a safe environment for employees and the public. This investigation should include how far radioactive contamination will spread, what cleanup will be required, anticipated exposure of the people within the area, and the public impact of such a fire.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 50404, 50407, 50536

49574 (LA—7746-MS) **Coprecal: process modifications for safeguards improvement. Addition of aliquot tanks (preliminary analysis).** Dayem, H.A. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 16p. P 02/MF A01.

This report gives a preliminary assessment of the improvement in materials accountability in a Coprecal process that has been modified by adding aliquot tanks to feed the process lines. Materials balance uncertainties are reduced significantly because each process line is fed with small batches from tanks for which precise measurements and frequent instrument calibrations are possible. 3 figures, 6 tables.

49575 (NUREG/CR—0562) **Specifications for germanium radiation detectors used for gamma-ray assay in safeguards applications.** Orvis, W.J.; Armantrout, G.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1978. Contract W-7405-ENG-48. 126p. (UCRL—52639). P 07/MF A01.

Nondestructive assay by gamma-ray spectroscopy is one of the preferred methods of nuclear material inventory. Germanium diodes are currently some of the most useful detectors available to carry out this work. This usefulness is due to the high resolution and relative efficiency of the devices. We investigated the current state of affairs of both high-purity and lithium-drifted germanium diode technology. In this report, we discuss the physics and engineering of detector fabrication and operation and the basic principles of assay by gamma-ray spectroscopy. Finally, we discuss the trade-offs for detectors used in several general assay categories, and we examine the electronics and systems used to process the detector outputs. Since we found no ideal system for all situations, we have listed the various specifications parameters, explained their meanings, and discussed their relevant trade-offs.

49576 (SAND—78-1922) **Description of the map board portion of the Security Operations Center of the Plutonium Protection System.** Ringler, C.E. (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 34p. P 03/MF A01.

This report describes the console map board which is part of the Sandia-designed Plutonium Protection System tested at the Hanford Works. The board displays areas under surveillance and contains alarm lights and switches for communicating with the system's computer.

49577 (SAND—79-0447C) **Small force engagement range (SFER) and its application to the gathering of behavioral data.** Link, B.D.; Shapiro, H.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 10p. (CONF-790707—14). P 02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

Although human performance and decision making play a decisive role in determining the outcomes of combat in real life, these factors have been inadequately taken into account in current combat models. A discussion is given of some of these factors and means of improving our knowledge about them using the SFER. Special attention is given to those factors germane to small forces combat and their integration into the Transportation Safeguards Effectiveness Model (TSEM).

49578 (SAND—79-1090) **Class notes from the first international training course on the physical protection of nuclear facilities and materials.** Herrington, P.B. (ed.). (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 521p. P 22/MF A01.

The International Training Course on Physical Protection of Nuclear Facilities and Materials was intended for representatives from the developing countries who are responsible for preparing regulations and designing and assessing physical protection systems. The first part of the course consists of lectures on the objectives, organizational characteristics, and licensing and regulations requirements of a state system of physical protection. Since the participants may have little experience in nuclear energy, background information is provided on the topics of nuclear materials, radiation hazards, reactor systems, and reactor operations. Transportation of nuclear materials is addressed and emphasis is placed on regulations. Included in these discussions are presentations by guest speakers from countries outside the United States of America who present their countries' threat to nuclear facilities. Effectiveness evaluation methodology is introduced to the participants by means of instructions which teach them how to use logic trees and the EASI (Estimate of Adversary Sequence Interruption) program. The following elements of a physical protection system are discussed: barriers, protective force, intrusion detection systems, communications, and entry-control systems. Total systems concepts of physical protection system design are emphasized throughout the course. Costs, manpower/technology trade-offs, and other practical considerations are discussed. Approximately one-third of the course is devoted to practical exercises during which the attendees participatein problem solving. A hypothetical nuclear facility is introduced, and the attendees participate in the conceptual design of a physical protection system for the facility.

49579 (SAND—79-1324C) **Unattended video surveillance systems for international safeguards.** Johnson, C.S. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 12p. (CONF-790707—7). P 02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

The use of unattended video surveillance systems places some unique requirements on the systems and their hardware. The systems have the traditional requirements of video imaging, video storage, and video playback but also have some special requirements such as tamper safing. The technology available to meet these requirements and how it is being applied to unattended video surveillance systems are discussed in this paper.

49580 (UCRL—82420) **Tools for assessing and designing material control processing monitors.** Dunn, D.R.; Candy, J.V.; Rozsa, R.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jul 1979. Contract W-7405-ENG-48. 11p. (CONF-790707—12). P 02/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

This paper reviews some of the computational tools for the assessment and design of Material Control and Accounting (MC & A) process monitoring components and illustrates their application to a Pu evaporator/concentrator unit operation. The codes include: (1) a general-purpose dynamic simulator for modeling the physical phenomenology of various chemical unit operations and their associated measurement systems, (2) an estimation code for simulating the operation of some modern signal processing algorithms (Kalman filter formulation), and (3) a set of detection algorithms for simulating on-line material loss detection algorithms for simulating on-line material loss detection. These codes can be used to address the issues of on-line material accounting and diversion detection for safeguarding SNM, and specifically with respect to arriving at meaningful performance measures. They can be used to compare state-of-the-art with state-of-the-practice and to study cost benefit tradeoffs. They are capable of treating stochastic models with nonlinear process and measurement dynamics and as a result should provide means for better designs of MC & A process monitoring components.

49581 Nuclear Fuel Service Center approach to reducing proliferation potential. Pirro, J. (Burns and Roe Ind Serv Corp, Paramus, NJ). *Am. Soc. Mech. Eng., [Pap.];* No. 78-WA/NE-9, 1-4(Dec 1978).

One of the concepts being studied as part of the Nonproliferation Alternative Systems Assessment Program (NASAP), is that of an international Fuel Service Center (IFSC). The purpose of an IFSC is to reduce the risk of nuclear weapons proliferation, with due consideration for using uranium resources more efficiently than the current Light Water Reactors without Plutonium Recycle. The IFSC's will prevent proliferation by restricting Weapons Usable Material (WUM) to the IFSC boundaries and providing the necessary safeguards to prevent diversion.

49582 Nonproliferation alternative systems assessment program (NASAP): an overview. Hanrahan, E.J. (US Dep of Energy, Germantown, Md). *Am. Soc. Mech. Eng., [Pap.];* No. 78-WA/NE-10, 1-8(Dec 1978).

The Nonproliferation Alternative Systems Assessment Program (NASAP) is an analysis of nuclear fuel cycle alternatives being conducted by the U.S. Department of Energy. Technical and other data obtained form the analysis will be available to support U.S. international nonproliferation policy objectives and assist policy makers in framing future U.S. nuclear developments. The program was initiated in early 1977 in response to President Carter's April 17, 1977 Nuclear Power Policy Statement. The basic proliferation concern is that a non-nuclear weapons state possessing a civilian nuclear power program which employs any weapons-usable material, such as plutonium, could divert the material and build a nuclear weapon in a short time if it had made previous preparations to do so. 2 refs.

49583 Gamma spectrometric methods for measuring plutonium. Gunnink, R. (Univ of Calif, Lawrence Livermore Lab). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 49-63(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

This paper reviews some new techniques developed for measuring plutonium. The features of plutonium gamma-ray spectra are reviewed and some of the computer methods used for spectrum analysis are discussed. The discussion includes a description of a powerful computer method of unfolding complex peak multiplets that uses the standard linear least-squares techniques of data analysis. This computer method is based on the generation of response profiles for the isotopes composing a plutonium sample and requires a description of the peak positions, relative intensities, and line shapes. The principles that plutonium isotopic measurements are based on are also developed, followed by illustrations of the measurement procedures as applied to the quantitative analysis of plutonium liquid and solid samples. 9 refs.

49584 Rapid nondestructive plutonium isotopic analysis. Fager, J.E.; Brauer, F.P. (Battelle, Pac Northwest Lab, Richland, Wash). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 64-70(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

Methods for plutonium isotopic measurements have been evaluated for nuclear safeguards inventory verification. A mobile, real-time, nondestructive assay, gamma-ray spectrometric measurement system has been assembled, moved and operated at several nuclear storage facilities to perform rapid, real-time plutonium isotopic measurements on Pu metal, Pu nitrate and Pu oxide. 17 refs.

49585 Future approaches to material control and accounting. Sherr, T.S.; Smith, G.D.; Wirfs, L.F. (US Nucl Regul Comm, Washington, DC). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 161-169(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

This paper presents a short description of the safeguards responsibilities and activities of the U.S. Nuclear Regulatory Commission (NRC), the NRC regulatory requirements for safeguards in the area of material control and accounting (MCandA), and the current NRC efforts which may result in significant changes in the current U.S. safeguards system. The preliminary results of NRC staff and contractor MCandA activities are discussed, as well as the recommendations of a recent NRC task force on MCandA. 9 refs.

49586 In-situ transuranium element measurement technique for wastes associated with power reactor fuels. Nielson, K.K.; Brodzinski, R.L.; Wogman, N.A. (Battelle, Pac Northwest Lab, Richland, Wash). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 201-206(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

A planar, 19 cmsup 2 intrinsic germanium detector has been used for in-situ analysis of plutonium and americium in contaminated laboratories and buildings. Detection limits depend on local background activity, but in typical surface measurements for decontamination work are about 0.005 nCi/cmsup 2 for sup 241Am (59.5 keV) and 0.5 nCi/cmsup 2 for sup 239Pu (17.2 keV). Specific analyses of sup 238Pu, sup 239Pu, sup 240Pu, and sup 241Pu are also possible using various gamma-rays. Attenuations equivalent to 10 cm of concrete can be tolerated for high levels of sup 239Pu and sup 241Am. 3 refs.

49587 In situ quantitative determination of transuranic elements in areas of high-level gamma radiation. Brodzinski, R.L.; Wogman, N.A. (Battelle, Pac Northwest Lab, Richland, Wash). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 253-260(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

A technique is described for passive neutron monitoring of transuranic elements. The method provides quantitative determinations of transuranic element concentrations in a variety of field situations where no other measurement method is possible. The technique can measure concentrations of transuranic oxides as low as 8 nCi/cmsup 3 and is capable of operating in gamma radiation fields up to megarads per hour. Information on chemical and isotopic composition can also be obtained from the data. Several successful applications of the technique are discussed. 1 ref.

49588 Neutron correlation counting for the nondestructive analysis of nuclear materials. Zucker, M.S. (Brookhven Natl Lab, Upton, NY). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 261-283(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

The technique of correlating the neutron pulse train from spontaneously fissioning material as an assay tool for nuclear material, its advantages, problems, and the underlying theory are discussed. There is currently a strong ffort to develop methods to determine isotopics by gamma spectroscopic techniques so that the neutron correlation assay method can be carried out in the field in a timely way without recourse to laboratory mass spectrographic analysis.

49589 Analytical methods for safeguards and accountability measurements of special nuclear materials, 1978. Yolken, H.T.; Bullard, J.E. (Ed.). (NBS, Washington, DC). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 288(1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

Twenty-seven papers by various authors are compiled. The presentations deal with advanced analytical chemistry techniques such as x-ray spectrometry for elemental content, neutron interrogation and gamma ray techniques for isotopic content, mathematical correlation models, and wet chemistry methods for elemental content. Examples of remote systems for handling highly radioactive samples for analysis are given. Various approaches are described which emphasize computer-controlled operating systems with built-in safeguards and quality assurance programs. Current trends in the fuel cycle, along with future approaches to control and accountability of special nuclear materials, are discussed. Most of the papers are separately indexed.

HYDROGEN

PRODUCTION

ELECTROLYSIS

REFER ALSO TO CITATION(S) 49598

49590 Liquid-permeable electrode. Folser, G.R. (to Department of Energy). US Patent Application 938,141. 30 Aug 1978. 12p.

This invention relates to electrodes for use in electrolytic cells and to a method for preparing the electrodes. It specifically relates to fluid-permeable electrodes suitable for use as anodes and cathodes in electrolytic hydrogen generation cells in which it is necessary to continuously remove the products of the electrochemical reaction. The electrode is prepared by mixing about 10 parts by weight of activated charcoal with from 6 to 10 parts by weight of a powdered thermosetting phenolic resin to form a mixture, compacting the mixture in a heated mold of the desired shape to melt the resin and form a green electrode and heating the green electrode to from about 550 to 750°C in a nonoxidizing atmosphere for a period of time sufficient to pyrolyze the resin and volatilize from about 40 to 60 weight percent of the resin present in the green compact to form a porous, rigid, liquid-permeable structure.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 49763

49591 Process for producing hydrogen from water using cobalt and barium compounds and compositions useful therein. Bamberger, C.E.; Richardson, D.M. (to Department of Energy). US Patent Application 934,768. 17 Aug 1978. 10p.

A thermochemical process for producing hydrogen comprises the step of reacting CoO with BaO or $Ba(OH)_2$ in the presence of steam to produce H_2 and novel double oxides of Ba and Co having the empirical formulas $BaCoO_{2.33}$ and $Ba_2CoO_{3.33}$. The double oxide can be reacted with H_2O to form Co_3O_4 and $Ba(OH)_2$ which can be recycled to the original reaction. The Co_3O_4 is converted to CoO by either of two procedures. In one embodiment Co_3O_4 is heated, preferably in steam, to form CoO. In another embodiment Co_3O_4 is reacted with aqueous HCl solution to produce $CoCl_2$ and Cl_2. The $CoCl_2$ is reacted with H_2O to form CoO and HCl and the CoO is recycled to the initial reaction step. The Cl_2 can be reacted with H_2O to produce HCl. HCl can be recycled for reaction with Co_3O_4.

CHEMISORPTION

REFER ALSO TO CITATION(S) 50143

TRANSPORT

REFER ALSO TO CITATION(S) 49593

49592 Transmission of gaseous hydrogen--a preliminary technology evaluation. Robinson, S.L. (Sandia Lab, Livermore, Calif). *Ind. Heat. (Pittsburgh);* **45**: No. 11, 20, 23-24, 26(Nov 1978).

Hydrogen embrittlement phenomena are discussed, and their implications for hydrogen transmission by pipeline are explored in this article which is an abridgment of a paper presented by S.L. Robinson at the Hydrogen Technology Seminar of the Institute of Gas Technology in Chicago, July 24-28, 1978. It is shown that soil movement or other events which yield and heavily deform the pipe, may be sufficient to cause failure because of the reduction of ductility due to hydrogen. 17 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 49592

49593 Transmission of gaseous hydrogen. A preliminary technology evaluation. Robinson, S.L. (Sandia Labs., Livermore, CA). *Ind. Heat. (Pittsburgh);* **45**: No. 11, 20, 23-24, 26(Nov 1978).

Hydrogen embrittlement phenomena are discussed, and their implications for hydrogen transmission by pipeline are explored. The effects of hydrogen on tensile and other properties of pipeline and which could influence its service are summarized. (LK)

OTHER SYNTHETIC AND NATURAL FUELS

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 49452

PREPARATION FROM WASTES OR BIOMASS

49594 Combustion characteristics of cellulosic fuels. Shafizadeh, F.; DeGroot, W.F. (Univ. of Montana, Missoula). pp 1-17 of Thermal uses and properties of carbohydrates and lignins. Shafizadeh, F.; Sarkanen, K.V.; Tillman, D.A. (eds.). New York, NY; Academic Press (1976).

From American Chemical Society meeting; San Francisco, CA, USA (29 Aug 1976).

The relationship between the chemical composition, combustion, heat release, and pyrolysis of cellulosic materials is discussed. The variation in the chemical composition of hardwoods and softwoods and in the different parts of trees is cited. Competing reactions in the combustion of wood and the effect of temperature, heating rate, particle size, and moisture and inorganic content on the combustion kinetics are illustrated. Analysis of the heats of combustion of various types of wood and char formation indicates the contribution of the lignin and extractives to the combustion process and ignition temperatures. The pyrolysis mechanism of cellulosic materials is outlined. (JSR)

49595 Kinetics of solid-phase cellulose pyrolysis. Broido, A. (Forest Service, Berkeley, CA). pp 19-36 of Thermal uses and properties of carbohydrates and lignins. Shafizadeh, F.; Sarkanen, K.V.; Tillman, D.A. (eds.). New York, NY; Academic Press (1976).

From American Chemical Society meeting; San Francisco, CA, USA (29 Aug 1976).

When the course of a pyrolysis is followed by measuring weight change as a function of time, it is possible to derive kinetic data for reaction steps in which no weight change occurs. Recognition of this fact has led to the determination of a new set of values for the rate constants and empirical formulas for each step in a previously proposed pyrolysis scheme. Thus modified, the model eliminates previous inconsistencies and gives theoretical pyrolysis curves consistent with experimental data at other temperatures. The Arrhenius equation for K/sub B/ in this scheme and the somewhat less reliable Arrhenius equation for K_2 permit computation of the relative contribution of the depolymerization and the char-forming processes as a function of temperature. For pyrolyses comparable to the 1000 hour experiment, the last step in the char-forming sequence involves a weight loss corresponding to the formation of $C_8H_6O_2$ per repeating cellobiose unit in the original cellulose. For longer times, at higher temperatures, or for cellulose contaminated with inorganic catalysts, an additional step leading to (C_7H_4O)/sub n/ occurs. It appears that the inorganic impurities have little direct effect on K/sub B/ but markedly increase K_2 and, even more markedly, K_5.

49596 Flash pyrolysis of holocellulose from loblolly pine bark. Fang, P.; McGinnis, G.D. (Mississippi State Univ., Mississippi State). pp 37-47 of Thermal uses and properties of carbohydrates and lignins. Shafizadeh, F.; Sarkanen, K.V.; Tillman, D.A. (eds.). New York, NY; Academic Press (1976).

From American Chemical Society meeting; San Francisco, CA, USA (29 Aug 1976).

The bark holocellulose (total polysaccharide fraction composed of cellulose and all hemicelluloses) was investigated. The pyrolytic products were identified and the effects of temperature and the influence of inorganic additivies were determined. The holocelulose samples were pyrolyzed by the method of continuous flash pyrolysis at temperatures of 100 to 600°C at intervals of 50°C. The volatile products were separated and identified in a continuous flow system, using a gas chromatograph/vapor phase thermal dissociation technique. (JSR)

49597 Comparison of the thermal degradation products of α-cellulose and Douglas fir under inert and oxidative environments. Hileman, F.D.; Wojcik, L.H.; Futrell, J.H.; Einhorn, I.N. (Univ. of Utah, Salt Lake City). pp 49-71 of Thermal uses and properties of carbohydrates and lignins. Shafizadeh, F.; Sarkanen, K.V.; Tillman, D.A. (eds.). New York, NY; Academic Press (1976).

From American Chemical Society meeting; San Francisco, CA, USA (29 Aug 1976).

The pyrolysis products of Douglas fir and α-cellulose under inert and oxidative conditions were determined by chemical ionization mass spectroscopy and gas chromatography-mass spectroscopy. Thermal analyses were made of the pyrolysis process. Pyrolysis temperatures were 340, 370, 400, 450, and 550°C. The pyrolysis

products were also studied by the sequential heating of a sample to progressively higher temperatures. Possible reaction mechanisms were discussed. (JSR)

ALCOHOL FUELS

49598 (LUTMDN/TMVK—5084/1-40(1978)) **Decrease of the dependence in Iceland on imported oil by the production of methanol utilizing domestic resources.** Jonsson, F. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Krafteknik). Dec 1978. 40p. (In Swedish). U 03/MF A01.

The technical and economical conditions for the production of methanol in Iceland have been studied. Electrolysis of water is discussed as a useful method for the production of hydrogen. Different possibilities to obtain carbon monoxide are also discussed. Thus the atmosphere, the sea, and the industries are mentioned as possible sources for carbon monoxide as well as combustion of carbon. It is concluded in the report that there are technical possibilities to replace all the imported oil with domestically produced fuels in Iceland.

HYDRO ENERGY

49599 (CONF-7805161—, pp 4.20-4.22) **Energy sources: hydroelectric power.** Hinman, G. (Washington State Univ., Pullman); Fassbender, A.; Hyman, B.; Thompson, C.; Watson, R.; Widman, G. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

It was felt that the creation of organizations such as the Tennessee Valley Authority, the Bureau of Reclamation, and the Corps of Engineers and the progress of their subsequent market activities have been the most important Federal stimuli to hydro power. Members of this discussion group believed that money loaned by the Federal government which had to be repaid served as a strong inducement to better management and more accountability than outright grants. The greatest difficulty with analyzing incentives to hydroelectric power for group members was that the incentives were really designed for much more than the production of power. Therefore, the analysis could be misleading.

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 50194, 50241

SOLAR ENERGY

REFER ALSO TO CITATION(S) 50251

49600 **Sun: mankind's future source of energy. Volume One.** de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978). 620p. (CONF-780114—P1).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Separate abstracts were entered into the data base for each of the 100 included papers. In addition, several abstracts were included in EAPA. (MOW)

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 49657, 49767

49601 (HCP/T4016—1) **Solar-climatic statistical study. Summary report. Volume 1 of 2.** (Northrop Services, Inc., Huntsville, AL (USA)). Feb 1979. Contract EG-77-C-01-4016. 60p. P 04/MF A01.

Design and operation of large scale solar and wind energy conversion systems should be based, in part, on knowledge of expected solar and wind power trends. For this purpose, historic data at 26 (SOLMET) National Weather Service stations were processed to provide preliminary planning data, in the form of statistical information, for selected daily average solar and wind conditions occurring and persisting for time periods of interest. Solar data are global radiation incident on a horizontal surface, and wind data represent wind power normal to the air flow. Empirical probabilities were constructed from the historic solar and wind data to provide a reasonable inference of the chance of similar climatological conditions occurring at any given time in the future. (Diurnal wind power variations were also considered.) Data used to obtain the daily average solar and wind power probabilities were combined into monthly averages and are presented in this volume as summary results. Average monthly, seasonal and annual solar and wind power trends were prepared to provide an overview for identifying areas for further investigation.

49602 (UHMET—79-09) **Summer weather on Haleakala, Maui.** Lyons, S.W. (Hawaii Univ., Honolulu (USA). Dept. of Meteorology). Apr 1979. Contract EG-77-G-03-1617. 65p. P 04/MF A01.

Meteorological observations from the summit of Haleakala, Maui, high-resolution satellite imagery, and rainfall climatology are examined to determine diurnal and day-to-day variations in weather both at the summit and along the slopes. Results show largest weather variations occur in response to the diurnal mountain heating cycle, while day-to-day weather changes result from continuous and systematic interaction between the local diurnal cycle and synoptic weather patterns. The diurnal cycle produces afternoon maxima and early morning minima in summit temperature, humidity, cloudiness, and rainfall. Summit maximum temperature and cloud amount depend directly on synoptic wind profiles and hydrostatic stability, while minimum temperature is positively correlated ($R = .78$) with the antecedent maximum temperature. Multiple regression equations are derived for summit humidity, cloud amount, maximum and minimum air temperatures, and wake cloud plume development.

49603 **Matthew P. Thekaekara memorial paper: a review of solar constant measurements.** Hickey, J.R. (Eppley Lab. Inc., Newport, RI). pp 331-337 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper includes a brief review of recent measurements of the solar constant. Emphasis is placed on the measurements of the Earth Radiation Budget Experiment of the NIMBUS 6 Satellite and the NASA Solar Constant Rocket Flight of June 1976. Some information on planned future measurement missions is included.

49604 **Method of stochastic time series for the characterization of the stability of solar insolation.** Benard, C.; Body, Y.; Wirgin, A. (ESE, Plateau du Moulon, France). pp 338-345 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Very simple methods of statistical analysis are applied to the study of thermal collection-storage systems, so as to be able to choose the optimum size for a system with a given use under given conditions. This problem is vast, and various techniques may be used in solving it. Here we shall develop a particular case of stochastic function time analysis, for the purpose of establishing the characteristics of a given climate with a view to implementing thermal collection storage systems there.

49605 **Reduced weather data for solar energy calculations.** Bruno, R. (Philips GmbH Forschungslaboratorium, Aachen, Germany). pp 346-347 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Detailed calculations were made to simulate the thermal behavior of buildings and their energy systems use, in general, hour-by-hour weather data. Using such numerical calculations to optimize a given building and energy system requires considerable computer time. It is therefore necessary to consider simplified models for both building and energy systems which can be solved for time periods longer than one hour. A simple analytic form for the weather variables is one way to achieve this. This paper indicates such a form which leads to a useful data reduction of weather parameters used in thermal performance calculations. The weather data used here is that of Hamburg, F.R.G.

49606 **Atmospheric radiation and sky temperatures in a tropical climate: Thailand.** Exell, R.H.B. (Asian Inst. of Tech., Bangkok, Thailand). pp 348-352 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Average upper air data are used to calculate downward atmospheric radiation under clear skies in Thailand by numerical integration of the radiative transfer equation up to 12 km. The corresponding effective sky temperatures are on the average 12.4°C less than surface air temperatures. The influence of cloud is shown to be less in Thailand than in Europe. The daily fluctuation of atmos-

pheric radiation at 7 a.m. is estimated from surface air temperatures and cloud observations using the Idso—Jackson empirical formula with a correction for cloudiness and an adjustment for the effect of temperature inversions.

49607 Simplified model for determining the spectral quality of daylight and the availability of solar energy at any location. Goldberg, B.; Klein, W.H. (Smithsonian Institution Radiation Biology Lab., Rockville, MD). pp 353-357 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Using solar irradiance data gathered over the past eight years (1968—1976) a very simple model for determining daily and hourly totals of solar irradiance has been derived. The simplified model works extremely well for broad spectral regions, i.e., the total irradiance, the visible (400 nm—700 nm), and the total IR (800 nm to 2800 nm). Smaller regions (100 nm bands) are not computed with the same accuracy because of the spectral dependency of such parameters as the albedo, water vapor, and ozone. Also, this model does not give good results around sunrise and sunset.

49608 Hourly stochastic insolation model for Kuwait. Puri, V.M. (Kuwait Inst. for Scientific Research). pp 358-378 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A stochastic Markovian insolation model for predicting hourly solar radiation values on a horizontal surface is developed. This statistical insolation model successfully predicts the time-sequence of the hourly solar radiation values. In addition, the non-deterministic direct and diffuse component is thereby estimated by using statistical techniques. The non-deterministic character of the direct component takes into account the cumulative effect of the scatterers and absorbers present in the atmosphere. Assuming the total solar radiation to be known, a correlation for determining the expected value of the direct component of solar radiation has been obtained.

49609 Data obtained from operating heliometric stations SHA-K7. Colomes, J.; Roland, S. (CEA, Gif-sur-Yvette, France). pp 379-383 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

SHA-K7 heliometric stations, designed by the French C.E.A., have been in operation for 2 years. After this period of systematic testing an electronics firm has been licensed for industrial development. Technical characteristics and data processing on mini-computer are described. Examples of recorded values are given and commented. Future outlooks of computer processing are approached.

49610 Relationship between diffuse and total solar radiation in computer simulation of solar energy systems. Butera, F.; Panno, G.; Ruisi, G. (Universita di Palermo, Italy). pp 384-388 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The diffuse to total radiation correlation developed by Liu and Jordan was tested for there Italian locations. An acceptable agreement was found between the regression lines and the ones found for two of the three locations. Using measured hourly values of total solar radiation on a horizontal surface, the corresponding hourly values of total solar radiation on an inclined surface at 45° facing south were computed. Comparative computer simulations were carried out making use both of the computed and the measured hourly values of diffuse solar radiation. Results show that the performance of the system is little affected by the use of the computed hourly diffuse radiation instead of the measured one.

49611 Estimation of the average diffuse component of the total solar radiation. Iqbal, M. (Univ. of British Columbia, Vancouver). pp 389-391 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A simple method of evaluating the diffuse component of the total solar radiation on a horizontal surface is suggested. It links the diffuse radiation at a location to its monthly average daily bright sunshine hours, n. If the local monthly average day-length is expressed by N, then this method proposes that the fraction of diffuse component of the total shortwave radiation on a horizontal surface may be expressed by 1 - n/N. The above procedure of obtaining diffuse component from sunshine hours has been employed in this study that includes several stations spread over a distance of about 5000 km.

49612 Measurement of solar radiation for energy conversion. Mani, A. (Raman Research Inst., Bangalore, India). pp 392-399 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The paper discusses the types of solar radiation measurements that are required for solar energy conversion purposes and the means of obtaining them. With the recent advances in radiometry and data processing and the development of techniques for the computation of radiation components from observations of meteorological elements at the ground, from extraterrestrial radiation values and from satellite measurements, it is now possible to obtain the information required on both shortwave and longwave components of net radiation. It is, however, necessary to use the WMO system of radiation standards and the facilities of the World, Regional, and National Radiation Centers, if the accuracy of the data collected is to be ensured.

49613 Monitoring UVB spectral irradiances at three latitudes. Klein, W.H.; Goldberg, B. (Smithsonian Radiation Biology Lab., Rockville, MD). pp 400-414 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An interference filter radiometer was developed to monitor ultraviolet B radiation in 5-nm bands. Data have been collected for one year at three locations: Barrow, Alaska (71°N); Rockville, Maryland (39°N); Balboa, Panama (9°N). Results indicate that 40% of the UVB is contained in the direct beam and 60% in diffuse radiation. The amount of ultraviolet radiation received at the earth's surface is strongly influenced by meteorological conditions as well as the ozone layer. Only on clear days can ozone values be used to predict ultraviolet radiation received at the earth's surface.

49614 Design of radiometer for measurement of total and net exchange solar radiation. Agarwal, K.N.; Verma, V.V. (Central Building Research Inst., Roorkee, India). pp 415-429 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A net exchange-radiometer and solarimeter employing copper plating have been developed at Central Building Research Institute, Roorkee. The various factors, total number of turns, diameter of constantan wire, dimension of bakelite plate, current and thickness of plating which affect power and voltage efficiencies have been studied theoretically and verified experimentally. It has been found that the maximum voltage efficiency is obtained at a plating thickness of 0.12 times the diameter of the wire. The number of turns per unit area varies from 42 to 50 for an element of size 4.5 x 1 x 0.2 cm. The plating current ranges between 40 to 60 milliampere. Based on these results net exchange and total radiometers have been designed and developed.

49615 Dependence of solar radiation availability on atmospheric turbidity. Chandra, M. (Central Building Research Inst., Roorkee, India). pp 430-434 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

In the determination of available radiant energy of the sun for use in application oriented problems, the computational methods, generally, play an important role. In this paper certain empirical relations for direct and diffuse components of solar radiation on a horizontal surface, which are based on measurements at Roorkee for clear (cloudless) sky conditions, are discussed. The two components of radiation are expressed as polynomials in sine functions of solar altitude for three different ranges of atmospheric turbidity specified in terms of Linke's turbidity factor. The radiation values based on these polynomial relations are also tabulated.

49616 Measurement of solar radiation (global and diffuse). Atmospheric turbidity and sunshine at Bhavnagar (Gujarat). Bhatt, M.M. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). pp 435-437 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Measurement of solar radiation for the last ten years at Bhavnagar (Gujarat) is presented. The monthly, seasonal, and annual variations of global and diffuse radiation, along with direct solar radiation, and in selected spectral regions - from which atmospheric

turbidity is calculated - are discussed. Also bright sunshine hours data for last ten years have been analyzed, suggesting the possible usage of sunshine in relation to seasons. Lastly, the possibility of computing total radiation with the help of evaporation and wind velocity of the place is envisaged.

49617 Determining the terrestrial, incident solar flux on an arbitrarily oriented surface using available solar/weather data. Clark, J.A. (Univ. of Michigan, Ann Arbor). pp 438-442 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Five models for computing the total (direct and diffuse) incident solar flux on an arbitrarily oriented surface are presented. These models range from that for a clear sky to those including the effects of cloudiness. The results are calculated using fraction of sunshine and total horizontal solar radiation, data frequently available, and empirical data on the ratio of diffuse to total horizontal solar flux. The models are compared for typical US locations but are applicable to other regions as well.

49618 Solar radiation studies for utilization of flat-plate collectors in an equatorial region. Goh, T.N.; Tan, K.J. (Univ. of Singapore, Kent Ridge). pp 443-447 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The feasibility of estimating total solar radiation on a horizontal plane through sunshine hours and other meteorological factors is examined with analyses of data from Singapore. No empirical relationships appear to give consistent estimates over different periods of time. The use of a weather indicator is suggested for improvement of solar radiation estimation. A set of charts are prepared for convenient estimation of radiation on tilted planes.

49619 Solar energy availability at Singapore. Rao, K.R.; Lim, B.P. (Univ. of Singapore, Kent Ridge). pp 448-453 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper presents the data on the availability of solar energy, its diurnal and annual variation at Singapore. Average day mean radiation intensities at midday lie between 550 and 770 Wh m^{-2} h^{-1} while on exceptionally clear days it would reach a value of 1100 Wh m^{-2} h^{-1}. About 73 percent of day's total radiation is received between 9 a.m. and 3 p.m. Monthly mean daily total solar radiation on a horizontal surface varies from 3.81 kWh m^{-2} d^{-1} in December to 4.96 kWh m^{-2} d^{-1}. Probabilities of radiation classes and sunshine hours are also presented. On average days daily diffuse radiation varies from 1.5 to 2.4 kWh m^{-2} d^{-1} which forms 35 to 45 percent of the daily total radiation. The hourly diffuse radiation varies from 50 to 250 Wh m^{-2} h^{-1}.

49620 Radiation and cloudiness over India. Ganesan, H.R. (Meteorological Office, Pune, India). pp 455-461 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An attempt has been made to derive a simple relation between direct solar radiation and other climatological parameters. Cloudiness and altitude of the sun are two parameters which are decisive in the estimation of solar radiation. The simple assumption made is that the direct Solar Radiation (Q) is proportional to the product of the Sine of Solar altitude (h) and brightness of the sky (B), where B = (100-C), if C is the cloudiness expressed in percent of visible sky i.e., Q = K B Sin h, where K is a constant. The nature and validity of the above analytical equation and the coefficient K (relative measure of the transparency of the atmosphere) have been discussed. The simple relation outlined above has been applied to 12 stations in India recording Global Solar and diffuse sky radiation and direct solar radiation (Q) has been estimated and compared with the actuals.

ECONOMICS

REFER ALSO TO CITATION(S) 49760, 50154, 50156, 50199, 50206, 50207, 50243, 50250

49621 (SAND—79-0346) **Assessment of the relative benefits of solar energy systems for application to a mixed-load community.** Peters, R.R. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract EY-76-C-04-0789. 18p. P 02/MF A01.

The results of an investigation of the relative benefits of both present-day and advanced technology solar energy systems are presented. Solar Total Energy (STE) systems, Small Power (SP) systems, and Solar Process Heat (SPH) systems designed for a mixed-load community are considered. The methodology used in sizing these systems is discussed and the before-tax benefit-to-cost ratio of these systems is used to evaluate their relative merits for two different energy inflation rate scenarios. The results indicate that both present-day and advanced technology STE systems are more economical than their SP system counterparts because they are able to sell a much larger fraction of the total energy collected by their collector fields. Since they also produce electricity (which is presently more valuable than thermal energy) with approximately the same size fields as their SPH counterparts, STE systems are more economical than SPH systems.

49622 Economist looks at solar energy: the government's role. Roseman, E.J. (US DOE, Washington, DC). pp 1-6 of Proceedings of 15th space congress. Cocoa Beach, FL; Canaveral Council of Technical Societies (1978).

From 15. space congress; Cocoa Beach, FL (USA) (26 Apr 1978).

This work places solar energy in the context of a marketplace for energy, and justifies the role of government in influencing solar energy market development and market penetration. It also examines the concept of commercialization, the effect of government incentives, and the proper timing of government involvement.

49623 Estimation of collector and electrical energy cost for steps in Japan. Tani, T. (Electrotechnical Lab., Tokyo, Japan); Sawata, S.; Tanaka, T.; Sakuta, K.; Horigome, T.; Karaki, S. pp 175-179 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Analyses of primary systems designed are made of specific configurations to concept feasibility of solar thermal electric power system in Japan. In order to evaluate the area of collector for various rated electric power capacities and electrical costs, the experimental data of the model system developed at Electrotechnical Laboratory, the cost models based on recent (1976) prices and the relative distribution of direct normal solar flux density were used.

49624 Utilization of solar energy at a low-temperature range. Part 2. Calculation on economical operation of solar plants. Gnugesser, E.; Mukherjee, S.K. pp 187-210 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An economic comparison is made between a solar water ad space heating system and an oil-fired heating system. The assumed boundary conditions are described. (MOW)

49625 Solar electrification and rural electrification: a techno - economic review. Desai, B.G. (Jyoti Ltd., Baroda, India). pp 211-213 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.) Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Many villages with small population remain to be electrified in India and other developing countries. Conventional electrification by way of distribution lines from large central stations is very uneconomic. Study of rural load in India shows that it is possible to meet this load by local generation of electricity by solar prime movers. Decentralized system of power generation has its own advantages. Preliminary analysis of costs also suggests that solar electrification is cheaper than conventional electrification in some cases. A detailed techno-economic study of various alternative technologies must be made before committing scarce resources for any rural electrification program.

49626 Cost of solar energy. Kowalczewski, J.J.; Sheridan, J.C. (Commonwealth Scientific and Industrial Research Organization, Highett, Australia). pp 219-223 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The need for a standard procedure for calculating the cost of solar energy is stressed. A procedure is proposed, similar to those currently used by power and fuel handling authorities, and based on unit cost of energy used. This concept is applied to compare the cost of energy provided by solar radiation with the cost of the same amount of energy, if it were to be provided by other energy sources that can be purchased, viz. oil, gas, electricity, LPG, wood, etc. The technique is extended to predict the likely cumulative benefit or loss, in present worth dollars, that the owner of the plant could expect in

future if he were to invest in solar energy now. The use of the procedure is demonstrated on selected examples.

49627 Solar heating in Belgium: a preliminary economic analysis. Gelders, L.; Berghmans, J. (Katholieke Universiteit, Leuven, Belgium). pp 229-233 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A preliminary economic analysis is performed to determine the feasibility of hot water and space heating solar systems in Belgium. Comparison is made between the solar system and an oil-fired conventional system. The study takes into account the influence of the heating and hot water loads, solar system size, cost of the solar system, cost of fuel, capital investment, inflation rates, etc. It is found that small-size solar systems can be justified economically in Belgium. Most of the heat of the most economical solar systems goes into hot water production and little into space heating.

49628 Real solar incentives. Cook, J. pp 234-238 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Typically solar researchers project their own ideals in performing research about solar applications. A 1977 study in Phoenix, Arizona, documents by a face-to-face interview technique those pioneers who have made solar decisions. A socio-economic profile of Solar Consumers describes them as typically middle-aged, conservative, professionals with relatively high incomes. A shortening of decision making time is one measure of a growing confidence level in solar. Although questions of economics and reliability are primary, those special qualities of personal gratification unique to solar appear among the most basic solar incentives.

49629 Marketplace realities and solar economics. Reiger, A.J. (Department of Housing and Urban Development, Washington, DC). pp 248-252 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The economic evaluation of solar energy systems has generally been based on the application of life-cycle costing techniques. Although this analytic approach is often used by business firms to make decisions on large capital outlays, it may not be readily transferable or even appropriate for residential applications of solar energy. This paper assesses life-cycle costing and solar energy from the perspectives and concerns of the major participants in the largest segment of the American market for new housing, for sale single family residences.

49630 Impacts of the National Energy Plan on solar economics. Roach, F. (Los Alamos Scientific Lab., NM); Ben-David, S.; Noll, S.; Schulze, W. pp 253-262 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The National Energy Plan (NEP) sets as a goal the use of solar energy in two and a half million homes in 1985. A key provision of the NEP (as well as congressional alternatives) provides for the subsidization of solar equipment. The extent to which these subsidies (income tax credits) might offset the impact of continued energy price control is examined. Regional prices and availability of conventional energy sources (oil, gas, and electricity) were compiled to obtain a current and consistent set of energy prices by state and energy type. The economic feasibility (life cycle cost basis) of solar energy residential space heating and domestic hot water is examined on a state-by-state basis. Solar system costs are developed for each state by fraction of Btu heating load provided. The total number of homes, projected energy savings, and sensitivity to heating loads, alternative energy costs and prices are included in the analysis.

49631 Economics of solar heating and cooling: a cautious view. Rosenberg, L.C. (National Science Foundation, Washington, DC). pp 306-314 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper takes a cautious view of solar thermal energy use as a reasonable alternative to fossil fuels for heating and cooling of buildings. The paper emphasizes two problems. One is the relationship between solar thermal heating and cooling of buildings and electric utility rates. The other is the social and private opportunity costs of solar thermal heating for single-family residences. The paper draws on NSF-funded research on the incentives and barriers to commercial adoption of solar heating and cooling of buildings.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S): 50154, 50156, 50199, 50206, 50209, 50243, 50244, 50245, 50246, 50247, 50248, 50249, 50250

49632 Solar heating and cooling: state and municipal legal impediments and incentives. Schiflett, M.; Zuckerman, J.V. (Univ. of Houston, TX). *Nat. Resour. J.;* **18**: No. 2, 313-336(Apr 1978).

The progress of heating and cooling buildings by means of energy from the sun will be highly dependent upon the economic and legal actions taken by states to supplement federal energy policy, which is only now beginning to be formulated in concrete terms. At the present time, state and local ordinances contain many impediments to advancement, but the situation is changing; seventeen states have passed enabling legislation to exempt solar installations from property tax assessments. Areas in which barriers can be additionally lowered and incentives increased include the following: access to sunlight, marketing and financing, design and construction, operating of solar heating and cooling and attitudes of institutions.

49633 (HUD-PDR—445) Protecting solar access for residential development: a guidebook for planning officials. Jaffe, M.; Erley, D. (American Planning Association, Chicago, IL (USA)). May 1979. Contract EX-76-A-29-1020-008. 151p. P 08/MF A01.

The purpose of this manual is to show planners how to use conventional land use controls to protect solar access in new residential development for space heating and cooling and domestic hot water. Protecting solar access essentially means regulating development in such a way that buildings and vegetation do not block sunlight and prevent solar energy use by neighboring buildings. In other words, protecting solar access means regulating to control shadows. While at first this may seem like a revolutionary idea, it will quickly be seen that protecting solar access is closely akin to traditional regulation to protect access to light, air, and views. This manual shows how solar access can be protected using existing authority of the police power or by private agreements. In addition to zoning, other traditional public regulations can be used to protect solar access, including subdivision regulations and environmental impact statements. Municipalities also can affect solar access in residential areas by planting street trees with an eye toward protecting solar access for the future. Finally, solar access can be protected by private agreements, usually covenants or easements, which communities often review as part of the development process.

49634 Policy implications of solar technology in the National Energy Plan. Garg, D.P. (Duke Univ., Durham, NC). pp 273-278 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Global and national energy supply and demand situation are briefly reviewed. Developments leading to the evolution of a national energy policy are discussed. The role of solar energy technology and its emphasis in the National Energy Plan are presented, and the implications of proposed policies related to solar technology are summarized.

49635 Strategy for the development of some low grade thermal devices. Kedia, Y.P.; Saksena, R.K.; Mitra, C.R. (Birla Inst. of Tech. and Science, Pilani, India). pp 279-282 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Feasibility reports of many low grade thermal devices have been received over the last few years. NCST expert panel on Solar Energy expressed optimism in its report about the early commercialization of some of these devices, prominent amongst these being solar water heaters and solar stills.

49636 Government incentive policies for solar energy with special reference to Canada. Kwon, O.Y.; Catania, P.J. (Univ. of Regina, Saskatchewan). pp 283-287 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The most important variable for a widespread use of solar energy is annual cash outlays for home heating. At present, in the absence of incentives for solar energy, annual heating costs with the solar energy system are higher than without it. Given the fact that various incentives are provided for oil, an appropriate energy policy is to provide incentives for solar energy to the same extent. Hence,

incentives provided for oil are analyzed and quantified. From this, it is found that solar energy would be cost-competitive with oil, if incentives equivalent to those for oil are provided for solar energy.

49637 Solar energy implementation centers. Hirshberg, A.S. (Booz Allen and Hamilton, Bethesda, MD). pp 288-292 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Widespread use of solar heating and cooling will not automatically occur when the economics become competitive, in part because of the characteristics of the building industry. An Implementation Center designed to improve communication to consumers and within the building industry will speed the use of solar heating and cooling. To be effective, the Center should be regional and provide communication both to the building industry and to solar researchers and manufacturers. The Centers should also provide Evaluation System information to potential users and evaluate solar projects. Two Implementation Centers could be funded at about $2 million each for a state the size of California through a small tax on natural gas and electricity sales.

49638 Costs and impacts of financial incentives for solar energy systems. Bezdek, R.H.; Roseman, E.J.;. (Department of Energy, Washington, DC). pp 301-305 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper estimates the costs and the impacts on market penetration of four different types of tax credits for solar energy systems. The public and private costs of each incentive are calculated and the impact on the number and type of solar systems installed and resulting energy displacement is estimated. Some problems involved in developing tax incentives for passive solar applications are discussed briefly.

49639 Utility involvement in solar energy and project SAGE. Hirshberg, A.S. (Booz Allen and Hamilton Inc., Bethesda, MD). pp 327-330 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Project SAGE is a 5-year program to examine the feasibility of the commercial use of solar water heating systems on apartment buildings. Part of the third phase of the project examined several roles which a utility could play which would help speed the use of solar energy. Utility involvement in solar is a subject of growing national debate. The purpose of this paper is to summarize some of the results of SAGE and to discuss some of the positive features of utility involvement in solar energy.

SOLAR ENERGY CONVERSION

REFER ALSO TO CITATION(S) 50242

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 49740

49640 (DOE/JPL/954527—8) **Investigation of test methods, material properties, and processes for solar cell encapsulants. Annual report.** Willis, P.B.; Baum, B.; White, R.A. (Springborn Labs., Inc., Enfield, CT (USA)). Jun 1978. Contract NAS-7-100-954527. 164p. P 08/MF A01.

Springborn Laboratories is engaged in a study of evaluating potentially useful encapsulating materials for the encapsulation task of the Low-Cost Solar Array project (LSA) funded by the Department of Energy. The goal of this program is to identify, evaluate, and recommend encapsulant materials (other than glass) and processes for the production of cost-effective, long-life photovoltaic solar modules. The results of an investigation of solar module encapsulation systems applicable to the Low-Cost Solar Array project 1986 cost and performance goals are presented. The 1986 cost goal for a 20 year life solar cell module is $0.50 per watt or $5 per square foot (in 1975 dollars). Out of this cost goal, $0.25 per square foot is currently allocated for the encapsulation in terms of raw materials, exclusive of labor. Assuming the flat-plate collector to be the most efficient module design, six basic construction elements were identified and their specific uses in module construction defined. In order to generate a comparative analysis, a uniform costing basis was established for each element. Extensive surveys into commercially available materials were then conducted in order to identify either general classes or specific products suitable for use for each construction element. The survey results were also useful in revealing price ranges for classes of materials and estimating the cost allocation for each element within the encapsulation cost goal.

49641 (DOE/NASA/20485—79/3) **Social and economic impact of solar electricity at Schuchuli Village: a status report.** Bifano, W.J.; Ratajczak, A.F.; Bahr, D.M.; Garrett, B.G. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center; Arizona State Univ., Tempe (USA)). 1979. 18p. (NASA-TM—79194). P 02/MF A01.

Schuchuli, a small remote village on the Papago Indian Reservation in southwest Arizona, is 27 kilometers (17 miles) from the nearest available utility power. In some respects, Schuchuli resembles many of the rural villages in other parts of the world. For example, it's relatively small in size (less than 100 residents), composed of a number of extended family groupings, and remotely situated relative to major population centers (190 km, or 120 miles, from Tucson). Its lack of conventional power is due to the prohibitive cost of supplying a small electrical load with a long-distance distribution line. Furthermore, alternate energy sources are expensive and place a burden on the resources of the villagers. On December 16, 1978, as part of a federally funded project, a solar cell power system was put into operation at Schuchuli. The system powers the village water pump, lighting for homes and other village buildings, family refrigerators and a communal washing machine and sewing machine. The project, managed for the US Department of Energy by the NASA Lewis Research Center, provides for two years of technical monitoring as well as a one-year socio-economic study to assess the impact of a relatively small amount of electricity on the basic living environment of the villagers. The project background, implementation details and current status of the technical and socio-economic assessment are presented.

49642 (SAN—1286-7) **Amorphous-silicon solar cells. Quarterly report No. 6, March 1—May 31, 1978.** Carlson, D.E. (RCA Labs., Princeton, NJ (USA)). Jun 1978. Contract EY-76-C-03-1286. 48p. P 03/MF A01.

Good agreement has been obtained between the photovoltaic characteristics of small-area, Schottky-barrier devices (1.45 mm^2) and large-area devices (2.2 cm^2). Short-circuit current densities of 6 mA/cm^2 have been observed for both areas with AMI illumination and no antireflection coatings. Laser scanning analysis has shown that good uniformity can be obtained in cells over 3 cm^2 in area. Ni—SiO_2 cermets have been used as ballast resistance layers in a-Si:H p-i-n solar cells, and these cells can be cured by the application of a reverse bias. Several devices with as many as 22 series-connected cells have been fabricated on glass substrates, but the efficiencies of these large-area cells have been limited to $<1.8\%$ due primarily to large contact resistances. Diffusion studies have shown that the diffusion of dopants such as phosphorus and boron will not be a problem during device fabrication. Preliminary results indicate that large stresses in a-Si:H films can degrade the photovoltaic properties. Annealing studies have shown that a-Si:H films can tolerate temperatures as high as 430°C for 30 min before serious degradation of the photovoltaic properties occurs. Schottky-barrier cells (no overcoatings) have been kept at 150°C in air for eight months without degradation. However, a potential degradation mechanism that has been identified by compositional profiles is theinjection of OH^- ions into a-Si:H in the vicinity of Schottky barriers.

49643 (SAN—1846-T1) **Preparation and characterization of hydrogenated amorphous silicon thin films and thin film solar cells produced by ion plating techniques. First quarterly progress report, January 1, 1979—March 31, 1979.** (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 30 Apr 1979. Contract ET-78-C-03-1846. 8p. P 02/MF A01.

A review of the ion plating deposition process, in which evaporation of a metal or semiconductor into a glow discharge is used to affect the character and surface bonding of the resulting thin film, is given. It is noted that ion plating increases the adhesion in the substrate of implanted films compared to evaporated or sputtered films. This greater adhesion allows a greater choice of substrate materials, deposition rates approaching those produced by simple vacuum evaporation methods, and the option of doping. Experimental results of the effect of magnetic fields on film deposition rates can be more than doubled by application of a field of 12 tesla. Experiments to determine the electrical and physical properties of a-silicon produced in the magnetic field are underway.

49644 (SAND—79-1127C) **Batteries for specific solar applications.** Clark, R.P. (Sandia Labs., Albuquerque, NM (USA)). 16 May 1979. Contract EY-76-C-04-0789. 11p. (CONF-790595—1). P 02/MF A01.

From DOE semi-annual review for photovoltaics; Gatlinburg, TN, USA (16 May 1979).

This program currently consists of three projects: a Battery/Photovoltaic Handbook being prepared by Bechtel Corporation, a Solar Data Base and Systems Study by Hittman Associates, and Sandia's Battery Systems for Photovoltaic Energy Storage. The program is outlined.

49645 (SAND—79-1290C) **DOE photovoltaic concentrator project.** Schueler, D.G.; Boes, E.C.; Shafer, B.D.; McDowell, J.F. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 4p. (CONF-790541—36). P 02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

The three major task areas of the DOE Photovoltaic Concentrator Project, which are concentrator solar cell technology, solar concentrator technology, and concentrator array subsystems, are described. Progress is reported in concentrator cell development, including cell efficiency achievements and cell assembly and production processes. The development of efficient, low cost comentrators and concentrator manufacturing processes is discussed. A brief discussion of research in the design, fabrication and operation of full-size photovoltaic concentrator array is given and some test results are reported.

49646 (SAND—79-1428C) **Batteries for specific solar applications.** Clark, R.P. (Sandia Labs., Albuquerque, NM (USA)). 17 Jul 1979. Contract EY-76-C-04-0789. 24p. P 02/MF A01.

Reproductions of slides used in an oral presentation are published. Thermal batteries are mentioned, and the program strategy for developing batteries for photovoltaic systems is outlined. (WHK)

49647 **Temperature dependence of the current-voltage characteristics of silicon MIS solar cells.** Shewchun, J.; Singh, R.; Burk, D.; Scholz, F. (Department of Engineering Physics and Institute for Materials Research, McMaster University, Hamilton, Ontario, Canada L8S 4M1). *Appl. Phys. Lett.;* **35**: No. 5, 416-418(1 Sep 1979).

Measurements on the dark I-V characteristics of Al-SiO/sub x/- (p-type) Si solar cells as a function of temperature have been used to elucidate one of the possible current conduction mechanisms in MIS solar cells. A good fit is obtained by using the diffusion current mechanism as described previously in our theory of MIS solar cells. There is little evidence in the data on our devices to support the thermionic emission model which is the alternate mode of operation proposed by other investigators.

49648 **Current conduction in Cr-MIS solar cells on single-crystal p-silicon.** Rajkanan, K.; Anderson, W.A. (State University of New York at Buffalo, Department of Electrical Engineering, 4232 Ridge Lea Road, Amherst, New York 14226). *Appl. Phys. Lett.;* **35**: No. 5, 421-423(1 Sep 1979).

New information has been obtained about the current conduction in Cr-MIS solar cells by studying their current-voltage relationship over a wide range of temperatures. It is demonstrated that majority-carrier tunneling over the combined barrier due to the interfacial oxide and the space-charge region dominates the I-V characteristics at temperatures below 250 °K for Cr-SiO/sub x/- (p-Si) solar cells. Insight about the shunt resistance and back-contact barrier is also obtained by plotting the activation energy versus applied bias. Majority carriers tunneling via interface states control the characteristics at higher temperatures for these devices, made on 0.4-Ω cm p-silicon.

49649 **Spray-deposited high-efficiency SnO_2/n-Si solar cells.** Feng, T.; Ghosh, A.K.; Fishman, C. (Exxon Research and Engineering Company, Linden, New Jersey 07036). *Appl. Phys. Lett.;* **35**: No. 3, 266-268(1 Aug 1979).

SnO_2/n-Si solar cells (area=1 and 4 cm^2) having AM1 efficiencies of 12.3% on single-crystal silicon and 10.1% on polycrystalline silicon have been fabricated. The tin oxide is deposited by spraying a $SnCl_4$ mixture onto heated silicon substrates. Using this low-cost process, large-area (20-cm^2) single-crystal cells having 10% efficiency have also been made. The smaller diffusion length and higher resistivity in the polycrystalline silicon (Wacker) accounts for its lower efficiency as compared to single-crystal cells.

49650 **Physics of solar cells.** Boeer, K.W. (University of Delaware, Newark, Delaware 19711). *J. Appl. Phys.;* **50**: No. 8, 5356-5370(Aug 1979).

The photovoltaic mechanism is analyzed with special attention to the boundary conditions between emitter and junction. In frontwall cells, these boundary conditions are rather simple and permit a transparent analysis. They connect the current, determined by the emitter/junction boundary, with the potential drop in the junction, determined by the same condition, and yield the current-voltage characteristic without invoking the superposition principle. The chemistry of the interlayer between the emitter and the junction may modify this characteristic when causing major interface recombination, resulting in a potential deformation. Such behavior is analyzed in more detail for the example of CdS/Cu_2S and Cd/sub z/Zn/sub 1-z/S/Cu_2S solar cells. Substantially improved agreement between the results of this theory and experiment is reached.

49651 **Collection efficiency measurements on a-Si : H solar cells.** Crandall, R.S.; Williams, R.; Tompkins, B.E. (RCA Laboratories, Princeton, New Jersey 08540). *J. Appl. Phys.;* **50**: No. 8, 5506-5509(Aug 1979).

The collection efficiency eta/sub c/ for photoexcited carriers is an important factor in solar cell efficiency. We have measured eta/sub c/ for a-Si : H-Pt Schottky-barrier solar cells and shown how it changes with the thickness of the barrier-depletion layer. The results show that carrier generation requires an electric field in addition to light.

49652 **Spectral-response and diffusion-length studies of amorphous, polycrystalline, ribbon, epitaxial, and single-crystal silicon MIS solar cells.** Dey, S.K.; Anderson, W.A.; Delahoy, A.E.; Cartier, C. (Rutgers University, Electrical Engineering Department, Piscataway, New Jersey 08854). *J. Appl. Phys.;* **50**: No. 6, 4425-4430(Jun 1979).

Spectral-response and diffusion-length characteristics of the various MIS cells developed at Rutgers and previously reported in the literature have been investigated. The cells, designated according to the type of Si substrate used, appear in the following descending order based on the above studies: (1) Monsanto single-crystal Si with a peak quantum efficiency (QE) of 87.4% and a diffusion length (L/sub n/) of 70 μm, (2) Wacker polycrystalline Si, peak QE=82.8%, L/sub n/=60 μm, (3) IBM ribbon Si, (4) epitaxial Si, (5) Mobil-Tyco EFG ribbon Si, and (6) amorphous Si (Plasma Physics Corp.). Theoretical plots of quantum efficiency and short-circuit current density are shown to be in reasonable agreement with experimental results. The enhanced ultraviolet response of the MIS cell compared to that of a commercial N/P junction cell is demonstrated even though the latter device has a peak QE of almost 100% and an L/sub n/ value of 184 μm. The spectral studies lend support to the conclusions derived from the previously measured electrical parameters. The Wacker polycrystalline material is shown to be a strong contender in the race for terrestrial solar-cell applications. a-Si cells studied in this report exhibit a cutoff at λ=0.75 μm, indicating the influence of the energy gap. This cutoff corresponds to a band-gap energy of 1.65 eV which is in agreement with the published data for similar materials.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 49594, 49595, 49596, 49597

49653 (SLU-IEM—79-1978) **Biomass in an old mixed conferous forest in Dalarna, Sweden.** Albrektsson, A.; Andersson, B. (Sveriges Lantbruksuniversitet, Uppsala. Inst. foer Ekologi och Miljoevaard). 1978. 43p. (In Swedish). U 03/MF A01.

An analysis is given of tree biomass in a mixed stand of pine (Pinus silvestris) and spruce (Picea abies) in middle Sweden. The described stand is on one of the experimental sites that are intensively studied in the Swedish Coniferous Forest Project.

49654 (TID—28551) **Technological and economic assessment of the utilization of rice straw residue from the California Sacramento Valley for on-farm power generation.** Horsfield, B.; Williams, R.O. (California Univ., Davis (USA). Dept. of Agricultural Engineering). Aug 1976. 95p. P 05/MF A01.

Agricultural residues are an alternative source of energy because (1) they are renewable, (2) they are a result of current production technologies, and (3) they exist in rather large quantities. This report deals with a specific crop residue, rice straw, grown in a particular area, the California Sacramento Valley. This area of California can produce approximately 2 million tons of straw which has enough energy to provide 30% of the fuel requirements for a 1000 megawatt plant. Currently this rice straw is burned after each harvest season, resulting in objectionable air pollution. Alternative uses for rice straw are examined in order to put energy use in perspective. Conversion processes are also discussed with a major emphasis placed on gasification. Methods of harvest, collection and storage are discussed and the economics developed for several methods including total harvest. On-farm utilization of the energy content of rice straw is discussed, including rice drying and irrigation pumping. Off-farm use is also covered.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 50421

PHOTOVOLTAIC POWER PLANTS

49655 **Mechanical energy storage system for a 10 KWe solar power pack.** Magal, B.S. (Indian Inst. of Tech., Bombay); Jain, S.V. pp 574-578 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An energy storage system is a necessary adjunct to any solar power generating unit, to ensure continuity of supply. An attempt has been made in this paper to design a 400 kWh flywheel storage system using indigenous technology, material and equipment available in developing countries for a 10 kWe power pack. A thermal energy storage system for the above power pack has also been designed and these two systems have been compared with respect to their impact on collector area, generator capacity and capital cost. This exercise indicated that a flywheel energy storage system, is feasible to build, operate and maintain in a developing country using intermediate technology: but, it is very very costly when compared with the hot water storage system.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 49625, 50339

49656 (DOE/JPL—1060-15) **Decision analysis for evaluating and ranking small solar thermal power system technologies. Volume I. A brief introduction to multiattribute decision analysis.** Feinberg, A.; Miles, R.F. Jr. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Jun 1978. Contract EX-76-A-29-1060. 32p. (JPL-PUB—79-12). P 03/MF A01.

Multiattribute decision analysis is a methodology for providing information to a decision maker for comparing and selecting between complex alternatives. A brief introduction to the principal concepts of the Keeney and Raiffa approach to multiattribute decision analysis is presented. The concepts of decision alternatives, outcomes, objectives, attributes and their states, attribute utility functions, and the necessary independence properties for the attribute states to be aggregated into a numerical representation of the preferences of the decision maker for the outcomes and the decision alternatives are presented. 50 references.

49657 (NP—23743) **Determination of potential solar power sites in the United States based upon satellite cloud observations. Final report, 5 June 1976—4 September 1977.** Hiser, H.W.; Senn, H.V.; Bukkapatnam, S.T.; Akyuzlu, K. (Miami Univ., Coral Gables, FL (USA). Remote Sensing Lab.). Dec 1977. 41p. NTIS.

Ground measurements of solar radiation are too sparse to determine important mesoscale differences that can be of major significance in solar power station location. A method is presented for use of cloud images in the visual spectrum from the SMS/GOES geostationary satellites to determine the hourly distribution of sunshine on a mesoscale in the continental United States excluding Alaska. Cloud coverage and density as a function of time of day and season are evaluated through the use of digital data processing techniques. Low density cirrus clouds are less detrimental to solar energy collection than other types; and clouds in the morning and evening are less detrimental than those during midday hours of maximum insolation. Seasonal geographic distributions of cloud cover/sunshine are converted to Langleys of solar radiation received at the earth's surface through relationships developed from long-term measurements of these two parameters at six widely distributed stations. The technique ultimately can be used to generate maps showing the geographic distribution of total solar radiation on the mesoscale which is received at the earth's surface.

49658 (SAND—79-0801) **Effect of operating temperature on the cost of energy from solar thermal electric power plants.** Lukens, L.L. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 88p. P 05/MF A01.

The operating temperature of a solar thermal electric power plant controls the efficiency of the collector field, the efficiency of the power generation system and the cost of the thermal energy storage system. The effect of these three items, as temperature is varied, on the annualized cost of energy produced by the system is evaluated for both stand-alone solar and solar diesel hybrid power plants. The type of solar power plant considered is one using a linear focus distributed collector field and a Rankine cycle power generation system. Systems using different collector performance models, Rankine cycle working fluids and thermal energy storage concepts were included in the evaluation.

49659 **Turning to the sun for power.** Hopkinson, J.; Bigger, J. *EPRI J.*; 4: No. 5, 18-21(Jun 1979).

In this article, Jenny Hopkinson, feature writer reviews the test program and scope of follow-on research planned by John Bigger, EPRI's project manager for solar-thermal energy conversion. Since 1974, Boeing Engineering and Construction has been developing a solar thermal power plant concept for EPRI that incorporates a closed Brayton cycle (gas turbine) system; it has applications for electric utility companies, and progress on this test is described. In mid-1975, Black and Veatch Consulting Engineers led a team to develop an open Brayton cycle, central-receiver concept and progress on that project is reported; this concept is designed to heat air to 2000°F to achieve higher thermal efficiency. A backup source of energy will be needed to assure the reliable production of electricity from solar thermal plants built for utility applications, so Solar Turbines International is modifying a commercially available 2.5-MW(e) gas turbine to demonstrate solar-fossil hybrid operation. Other programs underway include a solar stand-alone power plant with thermal storage, repowering units at existing oil- and gas-fueled power plants, and plants designed to provide industrial process heat.

CENTRAL RECEIVER

49660 (SAND—78-1177) **Solar Thermal Test Facility heliostat development.** Arvizu, D.E. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract EY-76-C-04-0789. 30p. (CONF-7806153—1). P 03/MF A01.

From International symposium on concentrating solar collector technology; Albuquerque, NM, USA (14 Jun 1978).

The STTF, which uses an array of 222 heliostats in a north field configuration, is capable of supplying 5 MWth energy onto a target on the tower. Data are being gathered from experience with this heliostat array at the STTF, which is currently a primary source of heliostat operational data. The STTF heliostat system is described, and performance data are discussed.

49661 **Optical analysis of solar facility heliostats.** Igel, E.A.; Hughes, R.L. (Sandia Lab, Albuquerque, NM). *Sol. Energy;* **22**: No. 3, 283-295(1979).

Useful insights into significant operating parameters are gained by treating the mirror collector system of a central receiver solar power station as an optical system. A method was developed for estimating the approximate size of the solar image cast by individual heliostats. As a consequence from the H. Coddington equations, a simple analysis of astigmatism was developed, the major aberration which describes optical off-axis image behavior of a focusing collector system. These predictive equations agree well with experiments performed with a spherical mirror over a range of angles of incidence exceeding 60°. Other than flat mirrors, several heliostat configurations were proposed and explored and were found amenable to the same analysis. 16 refs.

DISTRIBUTED COLLECTOR

49662 (GA-A—15340) **Fixed mirror solar concentrator for application to a 100 MW(e) electric generating plant.** Schuster, J.R. ; Neill, J.M.; Bass, J. (General Atomic Co., San Diego, CA (USA)). May 1979. Contract ET-78-C-03-2240. 6p. (CONF-790803—10). P 02/MF A01.

From 14. intersociety energy conversion conference; Boston, MA, USA (5 Aug 1979).

A design study was performed of a 100 MW(e) power plant that uses a Fixed Mirror Solar Concentrator (FMSC) to supply energy for steam generation. Various heat transport fluids were considered and draw salt was selected over Therminol 88 and sodium. The complete plant was modeled in a cost performance optimization code which automatically performed trade-offs such as reduced blocking vs increased piping costs, field piping heat loss vs pumping power, and fluid outlet temperature vs overall system efficiency. Various collector and receiver designs were studied and evaluated for their cost effectiveness. Operational requirements impacting the component designs were identified.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 49621

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 50462

49663 (CONF-790539—1) **Condensation and evaporation heat transfer with low-boiling temperature fluids.** Murphy, R.W.; Hoffman, H.W. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 4p. P 02/MF A01.

From Southeastern seminar on thermal sciences (SESTS); Boca Raton, FL, USA (10 May 1979).

Heat transfer research at ORNL related to OTEC and geothermal energy conversion power cycles are reviewed. (WHK)

49664 (COO—4931-T10) **OTEC support services. Quarterly technical progress report No. 3, 15 November 1978—14 February 1979.** (Value Engineering Co., Inc., Alexandria, VA (USA)). 28 Feb 1979. Contract ET-78-C-02-4931. 18p. P 02/MF A01.

Technical engineering and management support services provided for the Ocean Thermal Energy Conversion Program of the Ocean Systems Branch, Division of Central Solar Technology are

briefly described. The general task areas include (1) survey, analysis, evaluation, and recommendation concerning program performance; (2) program technical monitoring; (3) development and implementation of methodology to identify and evaluate program alternatives; (4) technical assessments; (5) OTEC system integration; and (6) environment and siting considerations. (WHK)

49665 (LBL—9053) **Zooplankton from OTEC sites in the Gulf of Mexico and the Caribbean.** Commins, M.L.; Horne, A.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 5p. (CONF-790631—9). P 02/MF A01.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

The spatial and temporal variations in the abundance of major classes of zooplankton were measured using standard methods, between June and October 1978, at two OTEC sites in the Gulf of Mexico and in the Caribbean near Puerto Rico. The usual oceanic patterns were found with highest numbers near the surface, especially at night, and lowest numbers at 800 to 1000 m. Absolute numbers varied considerably from site to site. As expected, copepods (usually divided between calanoids and cyclopoids) dominated the zooplankton at all sites.

49666 (PNL-SA—7115) **Proceedings of the ocean thermal energy conversion (OTEC) biofouling and corrosion symposium.** Gray, R.H. (ed.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1978. Contract EY-76-C-06-1830. 478p. (CONF-771001—). P 21/MF A01.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Separate abstracts were prepared for 39 of the 40 papers presented. One paper was previously included in the data base. (WHK)

49667 (PNL-SA—7115, pp 1-6) **Review of OTEC test facilities.** Kinelski, E.H. (Department of Energy, Washington, DC). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

The test program for biofouling, corrosion, and materials has been planned to match a very complex schedule for OTEC component and system developments. Included in this review are test programs for the following components: heat exchangers, demisters, turbines, generators, and instrumentation.

49668 (PNL-SA—7115, pp 7-11) **Status of OTEC environment and resource assessment studies.** Lewis, L.F. (Department of Energy, Washington, DC). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A brief review of environment and resource assessment (ERA) activities for the Ocean Thermal Energy Conversion (OTEC) program of the Department of Energy (DOE) is given. Management structure, progress through fiscal year 1977 and immediate plans for the effort are described. Preliminary site selection criteria are offered, example resource regions are discussed, and a suggestion concerning discharges is made.

49669 (PNL-SA—7115, pp 13-18) **Overview of the OTEC biofouling and corrosion program.** Perrigo, L.D.; Gray, R.H.; Jensen, G.A.; Laity, W.W.; Moles, R.G. (Battelle, Pacific Northwest Labs., Richland, WA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Biofouling and corrosion control are required if Ocean Thermal Energy Conversion is to be commercially successful. The program need, development methods, activities and organization of the OTEC Biofouling and Corrosion Project Office at the Pacific Northwest Laboratory, operated by Battelle Memorial Institute for the Department of Energy are outlined.

49670 (PNL-SA—7115, pp 19-29) **Effect of fouling on OTEC heat exchanger design, construction and operation.** Bell, K.J. (Oklahoma State Univ., Stillwater). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Heat exchangers proposed for OTEC plants will be among the largest ever constructed and will be designed to operate at relatively high heat transfer rates. They must operate in a difficult and poorly understood environment. Among the serious problems posed by this environment is the fouling of heat transfer surfaces by biological growth, corrosion products, and/or organic salt deposits. Even very thin surface deposits severely penalize heat exchanger efficiency and therefore plant economics. Several sources of fouling are surveyed, and the possible magnitude of the penalty is discussed emphasizing a dearth of knowledge and data. Fouling prevention, control, and removal techniques are described, together with their implications for design, construction, and operation of heat exchangers and the OTEC plant. Research programs on the several aspects of the problem are briefly described.

49671 (PNL-SA—7115, pp 31-44) **Marine microfouling and OTEC heat exchangers.** Corpe, W.A. (Barnard Coll. and Columbia Univ., New York, NY). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A major problem facing successful development of OTEC power plants is the formation of organic film on heat exchanger surfaces, that greatly reduce heat transfer coefficients. Metal and other solid surfaces, submerged in seawater, become fouled by microorganisms that attach, grow, and colonize extensively. Microbial cells and their extracellular, polymeric secretions are called a primary microbial film. Films are sustained mainly by organic nutrients in seawater with which they are continually bathed. Particulate debris may become entrapped in the slimy layer, adding to its complexity. While events leading to film formation are probably invariable, the rate of film formation and the extent of its development may vary with nutrient content of the water and other specific environmental factors. If control of microfouling is to be achieved, suitable test sites must be found and a thorough qualitative and quantitative study of periphytic populations must be undertaken as a first priority. Measurements of film thickness and thermal resistance are important but of limited value without an understanding of the biological, chemical and physical character of the film. Artificial upwelling of deep water and the presence of test or plant site hardware could seriously affect the surface water environment, rate of film formation on the heat exchanger surfaces, and biological characteristics of the film.

49672 (PNL-SA—7115, pp 45-49) **Mechanism of biofilm formation in seawater.** Mitchell, R. (Harvard Univ., Cambridge, MA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Microbial biofilms form rapidly on surfaces in the sea. Attachment of bacteria occurs in cold and warm water, and in the nutrient-deficient open ocean. Rapid flow across surfaces does not inhibit film formation. The process of biofilm formation involves four steps: (1) adsorption of biopolymers in water to a surface, (2) chemical attraction of bacteria, (3) reversible adsorption of bacterial populations, and (4) irreversible adsorption involving macromolecular fibrils. Adsorption of the primary film is followed by growth of a secondary bacterial population pennate diatoms and protozoa. Retardation of biofilm formation is dependent on interruption of this process. Repellents have been demonstrated to provide effective control.

49673 (PNL-SA—7115, pp 51-61) **Measurement of the formation and destruction of primary biofouling films.** Characklis, W.G.; Picologlou, B.F. (Rice Univ., Houston, TX). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Microbial fouling causes increased frictional resistance in pipelines, reduces heat exchanger performance and is thus responsible for large energy losses. Biofouling control to minimize these losses is generally by chlorine addition. However, this approach creates potential toxicity problems in receiving waters and a better understanding of fouling film development and destruction is needed to maintain satisfactory effluent water quality. Several methods for direct measurement of biofilm development are presented. Indirect measurements of film development that indicate deleterious effects of fouling are introduced. Laboratory systems for determination of rates and extent of fouling as a function of wall shear stress, water quality and bulk and surface temperature are outlined. As these methods and laboratory systems have been developed for the study of primary biofilms they are directly applicable to investigations of primary biofouling development and control in OTEC. Results indicate that substrate concentration significantly affects biofilm growth rate. However, maximum accumulation is controlled primarily by hydrodynamic wall shear stress in turbulent flow. Chlorine oxidizes biopolymers responsible for film structure and causes partial removal with aid of hydrodynamic wall shear forces. If removal is not complete, regrowth is more rapid than that observed on clean surfaces.

49674 (PNL-SA—7115, pp 63-75) **Observations on microfouling applicable to OTEC systems.** Gerchakov, S.M.; Roth, F.J.; Sallman, B.; Udey, L.R. (Univ. of Miami, FL); Marszalek, D.S. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Solid surfaces exposed to seawater become populated with bacteria in a few hours. Subsequent colonization by various microor-

ganisms produces a complex microfouling layer including extracellular metabolites, cellular breakdown products, waterborne detritus, and corrosion products on metal surfaces. Presence of this primary film on heat exchange surfaces may hinder heat transfer and be critical to OTEC systems operating at low theoretical Carnot efficiency. Metabolic activity in the film microcosm may enhance corrosion processes. Succession of periphytic microorganisms was observed on various surfaces, including glass, stainless steel, brass and copper—nickel alloys, in natural seawater. The nature of the periphytic community was influenced more by substrate composition than by the nature of background planktonic microbiota.

49675 (PNL-SA—7115, pp 77-80) **Development and evaluation of antimicrobiofouling systems for application in OTEC heat exchangers.** Willingham, C.A.; Fink, D.J. (Battelle, Columbus Labs., OH). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Recognition that microbiofouling is a major obstacle to successful operation of OTEC heat exchangers necessitates a new approach to antifouling techniques. Utilization of leachable toxins from surface coatings for preventing microbial or primary film formation is not considered applicable to OTEC. A concept to develop and evaluate a new approach to microbiofouling is proposed. The surface of potential heat exchanger materials under consideration for OTEC will be chemically modified to produce a thin, stable coating. Chemical properties of the coating will be modified using several processes to introduce passive or active antifouling properties. Passive layers will derive antimicrobiofouling properties from the ability to interfere with initial macromolecular fouling of surfaces. Active antifouling surfaces will interfere with formation of microbial films by degrading the macromolecular film as it is laid down. Evaluation of developed systems will utilize temperature-controlled, dynamic natural seawater exposures. Surface examinations will use various methods including microbiological and scanning electron microscopy techniques.

49676 (PNL-SA—7115, pp 81-87) **Some new possibilities for biofouling control.** Dexter, S.C. (Univ. of Delaware, Lewes). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Control of microbiological fouling on the seawater side of heat exchanger tubing is of vital concern to OTEC. Several new concepts for biofouling control including chemotaxis and wettability are presented and discussed in context with OTEC. Currently, these new techniques for fouling control are confined to the laboratory and are being evaluated on a relatively small scale. Potential benefits to OTEC that could result if the methods were developed at an accelerated rate are presented. It is suggested that DOE support basic research on microfouling control, which is vital to the success of the OTEC concept.

49677 (PNL-SA—7115, pp 89-106) **Microfouling of metallic and coated metallic flow surfaces in model heat exchange cells.** DePalma, V.A.; Baier, R.E. (Calspan Corp., Buffalo, NY). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Microfouling of solid surfaces by spontaneously adsorbed films and biological slimes limits heat exchange efficiency, and predisposes surfaces to thicker macrofouling deposits. Specific surface properties of materials (chemical, electrical, textural) strongly influence the nature of primary films, their subsequent resistance to shear-induced detachment and/or cleaning, and their immobilization of boundary liquid layers. To define the earliest adsorptive events that condition metallic and coated metallic substrates prior to organism adhesion, rectangular model flow cells were constructed to determine controlled shear rates of the following characteristics of spontaneously adsorbed films: change in streaming and zeta potentials; rest potentials; contact potentials; infrared spectra of initial deposits; film thicknesses; change in critical surface tension; surface texture; and associated inorganic elements prior to mineralization. Metallic substrate modifications emphasized nontoxic treatments and produced surface free energies, ranging from very high (produced by glow discharge treatment) to quite low (produced by siliconization). All substrates supported rapid adsorption of predominantly glycoproteinaceous films that increased the surface's zeta and contact potentials, and modified their critical surface tensions. Siliconized metal substrates retained surface properties characteristic of the original low energy coating, suggesting retention of their minimally adhesive properties. Typically, adsorbed films grew to about 100 A-thick in 72 hr, under static and flow conditions, using seawater from an aquarium containing barnacles, tube worms, algae, anemones, and tunicates. Clean titanium and aluminum alloy specimens became coated with millimeter-thick slime layers in a month's exposure in the same aquarium. The model heat exchanger surfaces were transparent to infrared energy, and allowed radiometric heat transfer measurements in real time.

49678 (PNL-SA—7115, pp 107-125) **Use of chlorine for antifouling on ocean thermal energy conversion (OTEC) power plants.** Fava, J.A. (Ichthyological Associates, Inc., Middletown, DE); Thomas, D.L. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Applicability of chlorine to solve Ocean Thermal Energy Conversion (OTEC) power plant biofouling problems was evaluated. Onsite sodium hypochlorite generation was found to be the preferred chlorination method based on its availability, operating costs, transportation, storage, and safety. However, initial capital costs were higher than for other available methods. Effectiveness and amount of chlorine required to prevent fouling are dependent on water quality including temperature, pH, dissolved oxygen, ammonia and chlorine demand, and the sensitivity of fouling organisms. Tropical areas proposed for OTEC sites will have the potential for fouling throughout the year. However, in the open ocean, fouling should be reduced, initially, and limited primarily to bacteria and unicellular organisms. After several years, macrofouling organisms will colonize the plant structure and may reduce heat exchanger efficiency. Chlorine in conjunction with water velocity will remove some of the fouling film. Corrosion of pipes appears to be more related to the type of metal and water velocity than to chlorine concentration. Continuous low level chlorination is more effective against hard shelled and soft-shelled macrofouling organisms. Intermittent chlorination will control slimes and soft-shelled macrofouling organisms. Intermittent chlorination will control slimes and soft-shelled macrofouling organisms. Continuous low level chlorination is recommended for OTEC since intermittent chlorination may allow bacteria and other organisms to settle. Although settled organisms may be killed after subsequent chlorination, their remains may reduce plant efficiency. Initial colonizers may also provide a suitable substrate on which macrofoulers may settle. 60 references.

49679 (PNL-SA—7115, pp 127-137) **Economics of alternatives for OTEC biofouling protection.** Schlesinger, H.A. (Gibbs & Hill, Inc., New York, NY). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Capital and operating costs for chemical and mechanical systems to reduce biofouling of Ocean Thermal Energy Conversion (OTEC) plants are presented. Systems considered are: (1) chlorination via seawater electrolysis and cylinder chlorine; (2) chlorine dioxide and chlorine dioxide plus chlorine; (3) bromochlorination and bromination; (4) ozonation; and (5) mechanical, electrical, and radiation. System capital costs are based on cases studied and equipment ordered for large (~ 1000 MW) fossil and nuclear power stations, adjusted for the special requirements of OTEC. Some power stations have cooling system capacities around 2,000,000 gal/min. Space, chemical storage, and auxiliary power requirements are also considered. Estimated operating and maintenance costs for alternatives are based on most probable methods of chemical dosing. Some known and unknown factors in OTEC biofouling protection are discussed particularly with respect to economics.

49680 (PNL-SA—7115, pp 139-145) **Dynamic model for prediction and control of primary film fouling.** Wilson, R.L.; Edgerton, G.A. (Western Instrument Corp., Oxnard, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A dynamic film modeling technique is demonstrated for prediction of primary film fouling on Ocean Thermal Energy Conversion (OTEC) heat exchangers. Environmental and biological interrelationships affecting fouling communities are analyzed by system modeling. The model expresses mathematically how each community partitions critical environmental and biological factors. Examination of communities includes characteristics such as growth, successional rates, and competition for space and resources. The technique permits derivation of optimal solutions given particular objectives concerning the biofouling system and subsequent sensitivity and perturbation analysis. The realism of the model and inputs required to achieve a more realistic biofouling system are discussed. Hypothetical simulation of a typical OTEC fouling situation is included and compares an initially stable system with one perturbed by a reduction of nutrient uptake. Results show a decrease in film thickness and an increase in stabilization time following nutrient reduction. Use of the model in ultimate control of primary film fouling of an OTEC heat exchanger is discussed. This process, when combined with any simulation model, permits the resource manager to explore effects of different options.

49681 (PNL-SA—7115, pp 147-158) **Methods for cleaning OTEC heat exchangers.** Hagel, D.; Conn, A.F.; Rice, M.S. (Hydronautics, Inc., Laurel, MD). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Fouling layer thickness on the seawater side of Ocean Thermal Energy Conversion (OTEC) heat exchanger surfaces must not exceed 25 μm for efficient operation. A review and evaluation of various fouling control techniques, including preventive and active cleaning methods, with respect to their applicability to OTEC heat exchangers are given. Evaluations criteria were: initial and operating costs, fouling control effectiveness, environmental effects, and adaptability to OTEC conditions and various heat exchanger designs. Preventive techniques include deaeration, debris screening, electrolytic hypochlorination, low surface energy coatings, ozonation, and ultrasonic and ultraviolet treatment. Active cleaning techniques include: the Amertap system, chemical cleaning, helically twisted inserts, the MAN system, slurries, and water jet cleaning. Based on available data, we concluded that the only methods adaptable to OTEC in the near future were chlorination, the Amertap and MAN systems, and chemical and water jet cleaning. However, further development and specific OTEC related studies are required before the methods can become operational. Incorporation of both preventive and cleaning capabilities is recommended for first generation OTEC plants.

49682 (PNL-SA—7115, pp 159-166) **Evaluation of mechanical cleaning methods for removal of soft fouling from heat exchanger tubes in OTEC power plants.** Fritsch, A.; Adamson, W.; Castelli, V. (David W. Taylor Naval Ship Research & Development Center, Annapolis, MD). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Reduction of seawater side heat transfer coefficients can occur as a result of biofouling and corrosion in the evaporator and condenser of an OTEC power plant. Methods for removing soft biofouling accumulations (primarily slimes) from the internal surfaces of seawater cooled heat exchanger tubes are being investigated. Several mechanical cleaning methods will be evaluated including two commercial systems: recirculating sponge balls and flow-driven brushes. Relative cleaning ability of each system will be measured with a single tube heat transfer monitor. Cylindrical and enhanced surface titanium and aluminum alloy tubes will be studied. Details of the test apparatus and experimental procedures are presented.

49683 (PNL-SA—7115, pp 167-179) **Effect of biofouling and cleaning on the external heat transfer of large diameter tubes.** Pandolfini, P.P.; Avery, W.H. (Applied Physics Lab., Laurel, MD); Jones, J.; Berger, L.R. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Two test series were completed at Keahole Point, Hawaii, which measured biofouling effects on exterior water side heat transfer coefficients in a model Applied Physics Laboratory (APL) Ocean Thermal Energy Conversion (OTEC) heat exchanger. Objectives of the tests were (1) to observe biofouling rates in tropical water typical of an ocean site and APL/OTEC heat exchanger conditions and (2) to measure water side heat transfer coefficients as a function of fouling time and cleaning. Testing with the apparatus is continuing, and results obtained through September 1977 are summarized. Experimental heat exchanger tubes obtained fouling coefficients of about 0.0005 Btu^{-1}-hr-ft^2 °F (8.8 x 10^5 $watt^{-1}$-m^2-°C/sup (b)/) in about 4 to 6 weeks. A device which wiped fouled surfaces reduced the fouling coefficients to < 0.0001 Btu^{-1}-hr-ft^2-°F (1.8 x 10^{-5} $watt^{-1}$-m^2-°C) on surfaces in contact with the cleaning pad.

49684 (PNL-SA—7115, pp 181-184) **Marine borers, potential threat to concrete and polymeric materials in OTEC systems.** Haderlie, E.C. (Naval Postgraduate School, Monterey, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Many marine organisms burrow or bore into solid substrates including wood, stone, concrete, and plastics. The organisms are particularly abundant and diversified in tropical waters and may be a threat to nonmetallic parts of Ocean Thermal Energy Conversion (OTEC) systems. Various marine borers are reviewed, and their possible significance for OTEC is evaluated.

49685 (PNL-SA—7115, pp 185-189) **Macrofouling: its effect on OTEC components.** DePalma, J.R. (Naval Oceanographic Office, NSTI Station, MS). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

During the life of Ocean Thermal Energy Conversion (OTEC) power plants, macrofouling organisms will gradually accumulate until all exposed surfaces are covered. Barnacles and other hard-shelled animals will be found to a depth of about 100 m. Hydroids and other soft-bodied forms will occur at all depths to the bottom. Added weight from attachment of hard-shelled foulers can be calculated and reserve buoyancy designed into the OTEC hull. Increased drag caused by barnacle roughened surfaces will be inconsequential. The inside of the cold water pipe, and condenser surfaces will remain unfouled. Attachment of macrofoulers to replacement modules and warm water intake conduits and screens can be minimized by component design.

49686 (PNL-SA—7115, pp 191-199) **Marine coatings.** Drisko, R.W. (Naval Construction Battalion Center, Port Hueneme, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Basic understanding of the composition, surface preparation requirements, and mechanisms of application and protection of coatings on marine steel and concrete structures is necessary for their fullest utilization on ships or fixed structures. Coating formulations have three basic components: volatile vehicle (solvent), nonvolatile vehicle (resin or binder), and pigment. Resin determines the method of curing. Coatings that cure by air oxidation of drying oils are not ordinarily used underwater. However, alkyd coatings are often used on atmospheric portions of steel marine structures. Commonly used solvent drying coatings (lacquers) are vinyls and chlorinated rubbers. Acrylic latex paint is sometimes used as a topcoat in marine atmospheric areas. Chemically curing coatings (epoxies, coal tar epoxies, urethanes, and polyesters) are used most frequently on marine (especially submerged) structures. Zinc-rich coatings can be used in atmospheric or, when topcoated, in submerged areas. Although abrasive blasting is the best method of surface preparation before coating, mechanical cleaning may occasionally be satisfactory. Cuprous oxide and organotin compounds are the most frequently used biocides in antifouling paints. Recent developments include use of organometallic polymers in antifouling paints and protective coatings and antifouling paints that can be applied underwater.

49687 (PNL-SA—7115, pp 201-207) **Preliminary investigation of methods to increase the strength of antifouling marine concrete.** Vind, H.P.; Keeton, J.R. (Naval Construction Battalion Center, Port Hueneme, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Experiments were conducted to ascertain the best procedure for preparing concrete from expanded ceramic aggregate impregnated with a mixture of tributyltin oxide (TBTO) and creosote. Two methods for impregnating the aggregate are compared. When aggregate was soaked in the TBTO/creosote mixture 48 hr, uptake was 16 g per 100 g of aggregate. When air was evacuated from pores in the aggregate before immersion in the TBTO/creosote mixture, uptake was 37 g per 100 g of aggregate. In other experiments, the effectiveness of several methods for removing the oily TBTO/creosote film from the aggregate surface were compared. Concrete made from impregnated aggregate washed with wet acetone had a compressive strength 82 to 90% that of concrete made from unimpregnated aggregate. When impregnated aggregate was unwashed, compressive strength was 71%.

49688 (PNL-SA—7115, pp 209-221) **Ocean thermal energy conversion (OTEC) corrosion problems and possible solutions.** LaQue, F.L. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

This paper describes corrosion problems that may be encountered in Ocean Thermal Energy Conversion (OTEC) plants and suggests how they may be solved. Advantages and limitations of candidate heat exchanger materials; aluminum, titanium, AL-6X stainless steel and CA-706 copper—nickel alloy are discussed. Corrosive media considered are surface and deep seawater, ammonia, and ammonia seawater mixtures. Attention is given to pitting, crevice corrosion, galvanic effects, stress corrosion cracking and corrosion fatigue. Possible design limitations imposed by potential corrosion effects on heat exchanger tubing and the availability of tube configurations for corrosion resistant materials are discussed. Suggestions are made for selection of materials for heat exchanger water boxes, tube plates and shells, water pipes, pumps, valves, and platforms. Research projects being administered by Battelle Northwest Laboratories for the Department of Energy (formerly Energy Research and Development Administration) to deal with problems described in the paper are identified and references to sources of preliminary results are provided.

49689 (PNL-SA—7115, pp 223-241) **Localized corrosion of aluminum alloys for OTEC heat exchangers.** Dexter, S.C. (Univ. of Delaware, Lewes). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Effects of dissolved oxygen, pH and various anions on rates of initiation and growth of pitting and crevice corrosion on aluminum alloy 5052 and pure aluminum are being investigated. Variations in pH and possibly some anions rather than dissolved oxygen account for increased corrosion rates reported for deep ocean exposures of 5000 series aluminum alloys. Implications of the results on qualification of aluminum for Ocean Thermal Energy Conversion (OTEC) and on approaches to corrosion control are discussed.

49690 (PNL-SA—7115, pp 243-263) **Corrosion and biofouling on the nonheat exchanger surfaces of an OTEC power plant: problems and present status.** Castelli, V.J. (David W. Taylor Naval Ship Research and Development Center, Annapolis, MD). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Many problems confront economical Ocean Thermal Energy Conversion (OTEC) operation. Deterioration of structural and functional components and biofouling of exposed surfaces which prevents efficient operation and adds excess weight to the floating platform are two major items. Techniques for effective long-term control of deterioration and corrosion have been actively investigated for many years. Successful solutions for most situations have been developed and, for the most part, can be directly transferred to the OTEC plant. Most problems in these areas are expected to be associated with scaleup and will require some advanced development. Current antifouling control systems are not effective for long-term fouling prevention. State-of-the-art antifouling coatings are limited to a maximum three year service life in temperate waters, and even shorter life in tropical waters. Underwater cleaning techniques may find utility on an OTEC plant. Additionally, recent advances in long-term antifouling materials are in development and testing phases and may provide a partial solution to the problem. 88 references.

49691 (PNL-SA—7115, pp 265-276) **Design factors influencing OTEC biofouling and corrosion.** Jenkins, J.F. (Civil Engineering Lab., Port Hueneme, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Biofouling and corrosion are critical to the economic feasibility of Ocean Thermal Energy Conversion (OTEC) plants. Control of biofouling and corrosion can involve active methods such as mechanical heat exchanger tube cleaning or passive methods such as material selection. The efficacy of any corrosion or biofouling control method is mainly dependent on system design. Effects of mechanical and environmental variables on corrosion and biofouling and their control in OTEC systems are outlined.

49692 (PNL-SA—7115, pp 277-286) **Cleaning procedures for aluminum pipe and tubing for biofouling and corrosion experiments.** Craig, H.L. Jr.; Nelson, J.; Munier, R.S.C. (Univ. of Miami, Florida). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A standard procedure for cleaning internal surfaces of aluminum pipes and tubes is required so comparable heat transfer measurements and biofouling and corrosion studies can be accomplished. The interior surface of an aluminum pipe or tube has a complex structure, depending on the basic alloy, degree of heat treatment, oils and lubricants and roughness of dies and mandrels used in fabrication. 6061-T6 Schedule 40, 1 in. dia aluminum pipe, similar to that employed in the Carnegie-Mellon University (CMU) Heat Transfer Apparatus was evaluated. The interior pipe surface had oil, lubricant, high temperature oxides, torn metal and a fine grained layer of metal. Typical cleaning procedures such as abrasive powders on bristle brushes, proprietary detergents, and chemical etches with caustic or a chromic-phosphoric acid mixture were tried. Results showed that mild caustic removed most oil, lubricant, and torn metal while providing a uniformly etched surface. However, the etch pattern was intergranular and thus the method was not completely satisfactory. Other methods were less satisfactory. Acid etch left a residue of smut, comprised of acid-soluble alloying elements and produced the intergranular pattern. Detergents did not remove torn metal, and barely cleaned the surface. Abrasive cleanser badly scratched the surface, leaving considerable debris and residue.

49693 (PNL-SA—7115, pp 287-291) **Experience with stainless steels in seawater.** Deverell, H.E.; Maurer, J.R. (Allegheny Ludlum Steel Corp., Brackenridge, PA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Stainless steels have been used extensively in seawater, but with generally mixed results. In conventional stainless steels, localized attack, associated with crevices from in-service fouling, has caused failures in tubular products such as condenser tubes. However, when kept crevice-free with automated or manual cleaning systems, stainless steels have worked satisfactorily in seawater. Laboratory tests for ranking resistance of stainless steel to localized attack have been developed and refined. Stainless steels have been developed using laboratory tests to define compositions that are least susceptible to crevice attack. Seawater exposures have been conducted and experience successfully related to laboratory tests. Use of stainless steel in Ocean Thermal Energy Conversion (OTEC) heat exchangers requires adequate heat transfer. The relative high strength of stainless steel, compared to copper alloys, allows use of thinner wall tubes which counteracts stainless steel's somewhat lower thermal conductivity. Resistance of stainless steel to formation of thick surface films also aids in maintaining high heat transfer.

49694 (PNL-SA—7115, pp 293-304) **Titanium and the OTEC environment.** Franson, I.A. (Titanium Metals Corp. of America); Covington, L.C. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Titanium has outstanding resistance to corrosion in seawater as evidenced by nearly 20 yr of actual service. Corrosion rates are low and pitting or crevice corrosion does not occur at temperatures below 120°C. High water velocity and presence of suspended abrasive particles cause only minor increase in corrosion rate. Unalloyed titanium is immune to stress corrosion cracking and corrosion fatigue. However, when high strength titanium alloys such as Ti-6A1-4V are used in seawater environments, pre-existing cracks may grow at accelerated rates under stress. Since titanium is nontoxic to marine organisms, biofouling can occur on immersed surfaces. Chemical control of fouling with chlorine or hypochlorites is feasible, since titanium is a standard material for handling these corrodents. Other possibilities for fouling control include abrasive particles suspended in the seawater and high velocity flow. Little information exists concerning titanium corrosion in ammonia, the Ocean Thermal Energy Conversion (OTEC) working fluid. Available data show no adverse effects in anhydrous ammonia and ammonium hydroxide. Titanium has demonstrated good resistance to potential OTEC environments. Corrosion resistance, light weight and good mechanical properties make titanium a logical candidate for heat exchanger surfaces and auxiliary equipment.

49695 (PNL-SA—7115, pp 305-318) **Aluminum alloys for use in heat exchanger tubing for OTEC applications.** Barkman, E.F.; Lindberg, R.I. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Recent technological advances have produced several aluminum alloys for seawater service. Advantages of using aluminum alloys in the massive heat exchangers proposed for Ocean Thermal Energy Conversion (OTEC) are evaluated with emphasis on engineering characteristics and economics. Aluminum alloy performance data based on up to 17 yr seawater testing and laboratory and pilot desalting plant testing are discussed. A world-wide atmospheric test program supported by a computerized corrosion data system provides a major source of data. Possible alloy modifications and several surface treatments including enhanced oxide film formations for reducing biofouling are evaluated. Response of aluminum tubing alloy surfaces to cleaning techniques are also examined. The possibility of producing aluminum tubing on site to reduce handling and transportation costs is discussed.

49696 (PNL-SA—7115, pp 319-328) **Mineralized scale formation during OTEC operations: a preliminary caution.** Wilde, P. (Univ. of California, Berkeley). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Besides the obvious corrosive scales and biofouling films formed on surfaces exposed to seawater, mineralogic scales such as carbonates, phosphates, silicates, and oxides may form on critical metallic and nonmetallic components in the water circulatory system of an Ocean Thermal Energy Conversion (OTEC) plant. Such minerals may precipitate or replace previous compounds due to (1) physical-chemical changes in the circulating seawater caused by plant operations, and (2) nucleation and crystallization sites on exposed surfaces of the plant not found in open seawater. Mineralogic scale is formed similar to boiler scale and pipe scale found in freshwater municipal water systems and to mineralized stones and deposits in organisms such as kidney stones and calculus on teeth. As seawater contains about 3.5% dissolved material, the problem of

mineralogic scale formation potentially is more serious in oceanic operations than for freshwater systems. Specifically, most mineralogic scales being nonmetallic have low thermal conduction properties and their formation would degrade the efficiency of heat transfer on heat exchange surfaces. Also these scales are harder than biofouling films and would be more difficult to clean using conventional methods. Several techniques for prevention or cleaning such scales are available although their efficacy on systems the size of OTEC is unknown at present.

49697 (PNL-SA—7115, pp 329-343) **Saturation state of calcium carbonate in seawater and its possible significance for scale formation on OTEC heat exchangers.** Morse, J.W.; deKanel, J.; Craig, H.L. Jr. (Univ. of Miami, FL). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Near surface seawater is supersaturated with respect to the calcium carbonates, calcite and aragonite, at potential Ocean Thermal Energy Conversion (OTEC) sites. Deep seawater at potential Atlantic Ocean sites is also supersaturated with calcium carbonate. Deep seawater at potential Pacific Ocean sites is slightly undersaturated. Since OTEC heat exchangers will operate in seawater, supersaturated with calcium carbonate, significant growth of scale may be expected if nucleation of calcite or aragonite occurs on heat exchanger surfaces. Potential calcium carbonate nucleation will be highest at cathodic surface sites which may be produced as the result of aluminum corrosion in seawater. Consequently, corrosion and scale formation may be closely related. Possible effects of biofouling on scale formation are unknown.

49698 (PNL-SA—7115, pp 345-352) **OTEC ocean engineering.** McGuinness, T. (National Oceanic and Atmospheric Administration, Rockville, MD). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Potential biofouling and corrosion problems that could affect various Ocean Thermal Energy Conversion (OTEC) subsystems are examined. Applicability of ongoing biofouling, corrosion, and ocean engineering projects is analyzed. At-sea limitations to OTEC operations are discussed. Relative severity of biofouling and corrosion on OTEC subsystems is evaluated to provide initial guidance for further research.

49699 (PNL-SA—7115, pp 381-390) **Introduction to the St. Croix biofouling and corrosion study.** Hirshman, J. (Tracor Marine, Inc., Port Everglades, FL); Meier, D.L.; Munier, R.S.C.; Taylor, B.F. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Coordinated heat transfer and corrosion measurements, microbiological studies and comprehensive chemical, physical and biological oceanographic measurements were made during an 11 week period aboard a manned U.S. Navy barge. The barge was tethered to a permanent ship's mooring in the open sea, 13 km (7 miles) north of St. Croix, U.S. Virgin Islands, in 3700 m (12,000 ft) of water. Caribbean tests were designed for comparison with similar heat transfer experiments being conducted in Hawaiian waters and to relate changes in heat transfer resistance to characteristics of intake waters, test systems, and test surfaces. Tests were concluded on September 30, 1977, and data and sample analysis is underway. Results and conclusions from the Caribbean tests will appear in a final report. The St. Croix biofouling and corrosion study and its objectives are reviewed. Facilities, equipment, and techniques are described, the kind of data collected is summarized; and some preliminary observations from data already analyzed are presented. However, no specific conclusions are possible at this early stage of analysis.

49700 (PNL-SA—7115, pp 391-399) **Gulf of Mexico biofouling and corrosion experiment.** Brooks, D.M.; Sheppard, W.T. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

The National Oceanic and Atmospheric Administration (NOAA) Data Buoy Office was selected by Battelle, Pacific Northwest Laboratory (PNL), to outfit and operate a Biofouling and Corrosion Field Expeeriment in the Gulf of Mexico. A large deep ocean data buoy will be used as the support platform and will be located in deep water south of Mobile, Alabama. The experiment will evaluate effects of microbiological fouling and corrosion in simulated Ocean Thermal Energy Conversion (OTEC) heat exchanger tubes. Heat transfer data will be collected periodically, using a specially instrumented heat exchanger system, and relayed ashore. Water quality of seawater flowing through the system will be monitored continuously. Data will be relayed ashore daily. Periodic visits will be made to the buoy to collect tube and water samples for chemical and biological analysis and to make visual inspections.

49701 (PNL-SA—7115, pp 401-411) **Description of a source book of selected and annotated oceanographic data for estimating biofouling and corrosion effects on OTEC plants at five potential sites.** Craig, H.L. Jr., Lee, T.; Michel, H.B.; Munier, R.S.C.; Hess, S.; Perlmutter, M. (Univ. of Miami, FL). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A source book was compiled for use by scientists and engineers to estimate the effects of biofouling and corrosion on an Ocean Thermal Energy Conversion (OTEC) plant at five potential sites. The sites are: Straits of Florida, Puerto Rico, Eastern Gulf of Mexico, Hawaii, and Guam. A supplement covering the Virgin Islands will soon be available. Site selection was based on: proximity to the United States or its territories, availability of a year-round temperature difference of at least 20°C between surface and deep ocean water, and bathymetry. Extensive site descriptions were included, to supplement the data compiled. Environmental variables selected for their effect on biofouling and corrosion in seawater are: temperature, salinity, currents, turbidity, Eh, pH, dissolved oxygen and carbon dioxide, trace metals, nutrients, and microbial cell counts. A brief discussion is given for each variable and includes measurement techniques, precision and accuracy, and specific effect on biofouling or corrosion. The book contains 755 data sets, 34 charts and 65 profiles. The bibliography includes 306 of 860 references located in the search. The 117 references deemed most pertinent to the work are annotated. A glossary and key word lists for computer searching are also included. Recommendations are presented regarding collection of needed data that are not available. Suggestions are included on how literature searching can be organized and implemented.

49702 (PNL-SA—7115, pp 413-422) **Ocean thermal properties in relation to the biofouling and corrosion experiment in the Gulf of Mexico.** Molinari, R.L.; Festa, J.F. (National Oceanic and Atmospheric Administration, Miami, FL). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Ocean thermal properties at a Gulf of Mexico biofouling and corrosion test site are reviewed in relation to their potential effects on biofouling rates. Primary biological differences in water masses affecting the site are discussed. Deep basin waters have less productivity, greater species diversity, and different dominant species than shelf and estuarine waters. Thermal characteristics of various water masses are included to aid interpretation of biofouling results. Frequency of occurrence of several events affecting the site is also given. Loop current eddies which transport deep basin chemical and biological species to the site have been observed from 2 to 4 times in 10 different yr. A table is presented showing number of monthly occurrences of tropical storms and hurricanes which can upwell deep chemical and biological species to the surface.

49703 (PNL-SA—7115, pp 423-445) **Synthesis and description of the existing historical inorganic nutrient data sets from three potential OTEC sites: Northern Gulf of Mexico, Puerto Rico, and St. Croix.** Cummings, S.R. Jr.; Atwood, D.K.; Parker, J.M. (Atlantic Oceanographic and Meteorological Labs., Miami, FL). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

A historical data set for inorganic nutrients was assembled from records supplied by NODC and others. Nutrient concentrations were reviewed at three proposed Ocean Thermal Energy Conversion (OTEC) sites: Northern Gulf of Mexico, Puerto Rico, and St. Croix. Nutrient variation in the Caribbean was small as denoted by tightly-packed scatter diagrams. Seasonal variation of nutrient concentrations was not seen in the Caribbean data set. Nutrient curves from the Northern Gulf of Mexico demonstrated the same general shapes as those from the Caribbean. However, the Northern Gulf was considerably more variable and richer. Large nutrient variations at the surface reflected the Mississippi River influence. Two Loop Current Eddy intrusions were reviewed. The effect was to inject higher dissolved oxygen and lower inorganic nutrient Caribbean water into the Gulf of Mexico. Work is continuing to elucidate range of nutrient variation caused by Eddies.

49704 (PNL-SA—7115, pp 447-454) **Design of a portable steady-state biofouling heat transfer apparatus for application to OTEC.** Messinger, B.L. (Lockheed Missiles & Space Co. Inc., Sunnyvale, CA). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Biofouling data applicable to heat exchanger design are needed to assess the probability of sustaining the high heat transfer

efficiency required for economic feasibility of Ocean Thermal Energy Conversion (OTEC). Various test devices have been considered and, in one case, developed and deployed to evaluate the effects of open ocean biofouling on heat exchange. The concept and features of another device being developed for use on small platforms deployed at candidate OTEC sites are described. The complete project including design, fabrication, development testing and operational deployment is under the direction of Battelle, Pacific Northwest Laboratories (PNL). The first three functions will be performed by Lockheed under contract to PNL.

49705 (PNL-SA—7115, pp 455-464) **Some factors influencing intake screen design for OTEC.** Hansen, R.; Nath, J.H. (Oregon State Univ., Corvallis). Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

An Ocean Thermal Energy Conversion (OTEC) power plant requires continuous large volume flow of clean warm and cold water. Diverse and abundant marine life may be encountered. Effective water intake screening must provide for plant and environmental protection. State-of-the-art screens operating at shore based power plants require a free water surface. Typically, vertical traveling screens provide effective plant protection. Environmental protection is improved by providing fish bypass and removal systems, limiting impingement time, and carefully designing mesh size and approach velocities. Cost optimization considers channel depth, flow volume, screen type, dimension, materials, operation and maintenance. A submerged static screen has also been investigated. Information for selecting the optimum screening system based on annual cost as a function of plant size, velocity, and required flow is provided. State-of-the-art screens utilizing a free water surface are emphasized. The free water surface provides easy access for repairs and operation supervision under unfamiliar offshore conditions.

49706 (SERI/TP—35-254) **Thermoelectric Ocean Thermal Energy Conversion.** Jayadev, T.S.; Benson, D.K.; Bohn, M.S. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1979. Contract EG-77-C-01-4042. 33p. (CONF-790631—6). P 03/MF A01.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

A novel thermoelectric OTEC concept is proposed and compared with the ammonia closed-cycle designs. The thermoelectric OTEC is a much simpler system which uses no working fluid and therefore requires no pressure vessel, working fluid pumps, or turbogenerator. These components are replaced by power modules which are heat exchangers integrated with thermoelectric generators. The thermoelectric OTEC offers several potential advantages including: simpler and more easily mass-produced components; higher reliability system performance through the use of a high level of redundancy and long-lived, solid-state thermoelectric generators; greater safety for crew and environment by elimination of the pressurized working fluid; and the possibility of lower system costs. These comparisons are discussed and plans for future work are presented.

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REFER ALSO TO CITATION(S) 50147

49707 (SERI/PR—35-313) **Systems analysis and testing (SAT) program. Progress report, October 1, 1978—March 31, 1979.** Bishop, C.J. (Solar Energy Research Inst., Golden, CO (USA)). Jul 1979. Contract EG-77-C-01-4042. 19p. P 02/MF A01.

This document describes SERI activities for the SAT program during 1 October 1978-31 March 1979. These include (1) a reevaluation of thermosiphon hot water systems; (2) a review of existing wind machine performance models; a study of the effects of wind transients, and control system and load management on energy capture; (3) a study of new concepts for solar ponds involving stratified ponds; (4) establishment of the SERI Computational Methods Center; (5) dissemination of F-chart; (6) a review of photovoltaic systems analysis methods; (7) development of a draft SAT Program Plan, SAT Management Plan, and an integrated System Test and Validation Plan; and (8) transfer of technical management of DOE contracts in the SAT program.

49708 UNESCO solar energy programme. Boiko, B. (Division of Technological Research and Higher Education, Paris, France). pp 9-11 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A very brief review of UNESCO's participation in planning and organization of solar energy research programs is given. (MOW)

49709 Analysis of alternatives for U.S. international cooperation in solar energy. Yim, H.C. (Energy Systems International, Washington, DC). pp 12-16 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A study to examine U.S. policies, priorities, criteria, needs and benefits of international cooperation in solar energy identified four major program components for increased emphasis; namely, Research and Development (R and D) Cooperation, Development and Demonstration (D and D) Cooperation, Demonstration and Assistance (D and A) Cooperation, and Assistance in Commercialization (AiC) Programs involving U.S. industry. Utilizing phased program planning and establishing approaches, guidelines, criteria and priorities, U.S. multilateral and bilateral cooperative programs can be effectively explored on a mutual benefit basis with developed and developing countries. This paper summarizes some of the study results to encourage the much needed dialogue among those interested in furthering the development of solar energy through U.S. international cooperation.

49710 Solar energy: UNIDO programme of action for developing countries. Swamy Rao, A.A. (United Nations Industrial Development Organization, Vienna, Austria). pp 17-21 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

There is a growing concern in both industrialized and developing countries towards the need to explore possibilities of utilization of non-conventional sources of energy. Therefore, possible techno-economic viable application of solar energy to the needs of the developing countries both in the industrial field and for uplifting of living standards with special reference to rural population is of great importance. It is recognized that energy is an integral problem of industrialization. Therefore, within the context of the aspiration of the developing countries to achieve the target of having 25% share in the world's industrial production by the year 2000, the importance of effective and accelerated development of alternative sources of energy, including solar technology, and promotion of eventual local manufacture of hardware is of great interest to the developing countries.

49711 Solar energy R and D programme of the European Communities. Strub, A.S. (Commission of the European Communities, Brussels, Belgium). pp 22-25 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The Commission of the European Communities carries out solar energy R and D in its own research establishments and by letting contracts to research institutions in its Member Countries. The paper describes this latter part of activities, which are based on a four year program funded with 17.5 million European units of account (~ 20 million dollars). The program comprises six sectors: (1) dwellings/habitat, (2) power plants, (3) photovoltaic conversion, (4)photochemistry, (5) biomass, and (6) radiation data. Emphasis is placed on sector (3), followed by (1) and (2).

49712 Some solar energy programs in the United Nations System. Chatel, B. (United Nations, New York, NY). pp 26-30 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The report outlines recent activities in the United Nations System concerning solar energy applications for the benefit of developing countries. Summaries are provided of some of the main programs undertaken in the field of solar energy by a number of agencies and bodies of the United Nations System.

49713 Status of the CCMS and IEA solar energy activities. Morse, F.H. (Energy Research and Development Administration, Washington, DC); Blum, S. pp 31-32 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Two major multinational programs are presently underway, providing several approaches to cooperation in solar heating and cooling. The NATO Committee of the Challenges of Modern Society (CCMS) initiated a Solar Energy Pilot Study in 1973, and 1975 the International Energy Agency initiated the Solar Energy Research and Development Cooperative Program. A brief review is given.

49714 Solar energy in Latin America: an overview. Alonso, M.; de Santiago, M. (Department of Scientific Affairs, Washington, DC). pp 33-38 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper analyzes in general terms the energy problem in Latin American countries, emphasizing the strong dependence of the Region on oil. An outline of the available alternative energy sources is presented and it is concluded that solar energy, on account of the special geographic and social characteristics of the region, could contribute substantially to the development of isolated rural communities. There is also, for each country, a brief report of the state of the art in solar energy and a list of the main institutions working in research and development.

49715 Are all solar energy applications necessarily appropriate technologies. Lawand, T.A.; d'Ombrain, G.L. (McGill Univ., Quebec, Canada). pp 39-42 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Renewable energy technologies must be appropriate in meeting the real needs of the populations and societies they serve. Not all solar based programs or technologies are necessarily appropriate. Some criteria are listed which outline the characteristics of acceptable solar equipment and systems. Some cases of inappropriate technologies are described briefly.

49716 Planning considerations for large scale solar energy use in developing countries. Stambolis, C.N.D. (Intermediate Tech. Development Group, London, England). pp 43 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press, Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Various groups of developing countries are first being identified as being suitable for a large scale application of solar energy. Then different types of solar energy conversion systems are briefly described which could be applied to the above groups of countries. Correlations are presented, for each of the above groups of countries, by means of graphical representation between the per capita "gross national product" and average yearly solar radiation levels. Using this method a general assessment is first made of each country's relative potential for large scale solar energy utilization.

49717 India's national solar energy research and development programme. Ramachandran, A. (Department of Science and Technology, New Delhi, India). pp 44 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The highlights of Indian Solar Energy Program and the achievements of the Research and Development efforts are described.

49718 Federal Republic of Germany programme technologies for the utilization of solar energy. Klein, H. (Non-Nuclear Energy Research and Tech., II-Section, Bonn, Germany); Wagner, H.F.; Friedrich, F.J.; Heinzelmann, P.J. pp 45-50 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The R and D program for the utilization of solar energy was launched at the beginning of 1974 as part of the non-nuclear R and D program. The Federal Minister for Research and Technology is now continuing with a new program based upon the experience gained during the last 3 years. This program was launched in September 1977. The major objectives are: thermal utilization, electrical utilization (thermal engines and photocells, wind energy, water power and wave energy), biological and chemical utilization, general measures (data compilation and evaluation, standardization of components and systems, systems analysis) and international co-operation.

49719 National (Italian) solar energy program. Storelli, V. (Turin Univ., Italy); Troise, G. pp 51-53 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The short-term directions to be followed in research and development are outlined: a) data on solar radiation in Italy and meteorological data; b) solar energy for the generation of low temperature heat required for housing and agriculture; c) the production of high temperature steam (conversion of solar energy into mechanical and electrical energy). This program also includes investigation of the photovoltaic process and medium-long term research in the field of photochemistry and biomass.

49720 Report on the development of solar energy in France. Devin, B. (Commissariat a l'Energie Atomique, Paris, France); Pheline, H.J. pp 54-58 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper describes what structural arrangements have been taken in France in order to promote and coordinate the development of solar energy, either for research, development or for applications, and what are the main present realizations and their applications.

49721 UK solar energy programme in 1977. Hall, D.O. (Univ. of London King's College, England); McVeigh, J.C. pp 59-63 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper reviews the progress and describes the main features of the 1977 UK solar energy program. The emphasis is on solar water heating and space heating, where the most immediate practical applications can be found.

49722 Accomplishments of the United States Federal Solar Energy Program. Herwig, L.O. (Energy Research and Development Administration, Washington, DC). pp 64-67 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The US Solar Energy Program has grown rapidly from a very low level of Federal funding in 1970 to about $290M in 1977. These funds have been applied to research, development and demonstration (RD and D) of solar technologies including water heating; space heating and cooling; industrial process heat; solar electric systems including solar thermal, photovoltaic, wind and ocean thermal technologies; and, fuels from biomass. Results of RD and D incidate strongly that solar heating, wind conversion, and fuels from biomass can begin to contribute significantly to US energy resources by 1985. As these technologies continue to grow in impact, other solar technologies could begin to contribute in the late 1980's and early 1990's leading to a substantial impact on US energy needs by the end of this century.

49723 Solar energy research, development and demonstration program in Kuwait. Malik, M.A.S. (Kuwait Inst. for Scientific Research, India); Shihab-Eldin, A.; Puri, V.M.; Debs, A.S.; Lokmanhekim, M.; Sodha, M.S.; Warfield, G. pp 68-71 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Kuwait has established a modest RD and D program in solar energy in recent past. The program concentrates on three main areas namely: Solar Cooling and Heating of Buildings; Solar Thermal Conversion and Agricultural applications of solar energy. The objective of this program is to commercialize solar technology in Kuwait. In this paper some of the projects in the solar energy program are described.

49724 National solar energy R, D and D program of the Netherlands. van Koppen, C.W.J. (Eindhoven Univ. of Tech., Netherlands). pp 72-73 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The National Solar Energy R, D and D Program, as recently formulated by a group of experts supplemented by a government representative, covers the applied research which can be expected to find practical application within the next 25 years. Pure scientific research and industrial development are mostly not incorporated in the program, because the fundings for this kind of research proceed from the autonomous means of the universities and the industry respectively. The program as such is not (yet) officially authorized by the government. However it is informally accepted as the line of action for the research policy.

49725 Solar energy programmes of Thailand. Chantavorapap, S. (National Energy Administration, Bangkok, Thailand). pp 79-100 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A solar energy program of Thailand is implemented by various local institutes of technology, universities, and other government agencies and coordinated at all stages of its development by the National Energy Administration. Its objective is to provide technologies for utilization of solar sources of energy, to increase availability of energy in the rural area from its own sources, to include solar sources of energy in national energy planning when appropriate, and to alternatively use, supplement and substitute the conventional sources of energy with renewable ones when it is feasible.

49726 National programme for solar energy development in the Philippines. Terrado, E.N. (Department of Energy, Philippines). pp 101-105 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A National Energy Plan was subsequently drawn up in the latter part of 1976 which for the first time in the country's energy planning exercises, officially considered non-conventional energy resources, such as solar energy, as having significant contributory potential. This recognition was further formalized by Presidential Decree No. 1068 which directed the EDB to accelerate the research, development, demonstration and utilization of non-conventional energy. A latter decree, Presidential Decree 1206, which expanded the EDB into a Department of Energy carried over all pertinent provisions of PD 1068. Non-conventional energy was defined as being mainly solar energy, with the important categories of direct solar, wind and biomass energy.

49727 Solar energy R and D in Iran: the approach and the philosophy. Vojdani, S.; Woollam, V.J. (Aryamehr Univ. of Tech., Tehran, Iran). pp 106-117 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The approach and the philosophy of the solar energy R and D program in Iran are stressed. Solar energy is important to developing countries not only as an alternative energy source but also as a challenging new field of basic research with interesting opportunities for technological development and international collaboration.

49728 Solar energy developments in Ireland. Lewis, J.O. (University Coll., Dublin, Ireland). pp 118-122 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The work being done in Ireland to realize the potential of ambient sources of energy by a variety of agencies in both the public and private sectors is described. There is particular interest in agricultural applications, and wind power, photovoltaics and solar thermal applications are other areas being advanced. Given that the financial resources available are small a promising amount of activity is underway.

49729 Plans and prospects for solar energy utilization in Malawi. Kennedy, W.K. (Univ. of Malawi, Blantyre). pp 123-127 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The paper outlines the progress made over the past few years regarding the prospects for solar energy use in the country. These include water heating, agricultural processing/preservation, and rural water supplies. The following propositions have been put forward to further the introduction of a solar energy program: feasibility studies; the establishment of an Alternative Energy Development and Implementation Unit; the promotion of pilot projects, and the formulation of a national energy policy - to include a plan for village energy development. A strategy for the development of solar energy in both urban and rural areas is suggested and a case study of a self-help development project in Malawi provides a model for introducing rural energy schemes.

49730 Determination of the optimum site in Mexico for an International Solar Energy Experimental Center. Hernandez, E.; Best, G.; Mayer, E. (Universidad Nacional Autonoma de Mexico, Mexico City). pp 128-134 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Due to the necessity of selecting the optimum location for the Mexican Solar Energy Experimental Center, studies were made on various possible sites. These studies were directed towards factors such as: insolation and climatic characteristics, living conditions, technical and scientific infrastructure, accesibility and local socio-economic conditions. The short and long term objectives of this Center are also summarized. After a close examination of global information, seven places were selected.

49731 Solar energy activities in western Canada. Catania, P.J. (Univ. of Regina, Saskatchewan). pp 135-137 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The rate of growth of the Canadian Solar Energy Society, particularly its chapters in western Canada, integrated with major projects recently announced by provincial governments, research units, and universities has stimulated a growing public awareness of the potential, now and in the near future, of solar, wind, biomass and geothermal energies. This paper reviews these provincial and university research-demonstration projects.

49732 Notes on ESCAP activities in solar and other alternative energy resources. Elmahgary, Y.S. (Natural Resources Div., Bangkok, Thailand). pp 138 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

ESCAP's main interest in solar energy at present is as a component in a program to stimulate the provision of appropriate energy supplies in rural areas, which in turn is a component in integrated rural development.

49733 Solar engineering as a subject for scientific research and university education. Borglin, S. (Lund Inst. of Tech., Sweden). pp 139 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Present efforts in the utilization of solar radiation are based upon the most valuable knowledge given to us by a small group of solar pioneers. In spite of the high standard of these early works, the use of solar energy has progressed very slowly. The reasons for this delay are discussed in the introduction together with remarks concerning the actual situation in solar research and development.

49734 Prospects for harnessing renewable energy sources in developing countries. Ramakumar, R. (Oklahoma State Univ., Stillwater). pp 140-144 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Renewable energy sources can provide a viable alternative to supply energy to satisfy the basic needs of life and build up rural economic units that are vital to the stability and well being of developing nations and eventually of the entire world. Judicious utilization of both the human and the energy resources, without the sudden infiltration of advanced technology in a primitive environment, can initiate the multiplier effect in their economies and lead to a better life for millions of people around the world. Prospects for accomplishing this objective are discussed along with some system concepts and their economics.

49735 Solar energy in southern Africa. Schaller, B.G.A. pp 145-149 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper reviews the state of solar energy research and application in southern Africa. The history of energy and solar energy, the requirements at present and various predictions for the future are outlined. Wind, wave, wood, and similar solar energy resources are also briefly discussed.

49736 Potential of the use of solar energy in rural areas in Viet-Nam. Tran, V.V. (Univ. of Agriculture, Serdang, Malaysia). pp 150-164 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

In order to assess the potentialities of solar energy utilization in Viet-Nam, theoretical computed date on the monthly values of solar radiation available, and sunshine hours at different cities in Viet-Nam were reported. The main goal of this study is to introduce into Viet-Nam the technology of using solar energy in meeting the water and energy requirements of the rural populations, and finally to encourage the participation of Vietnamese scientists to establish

programs of research, development and to exchange their works and experiences with ISES.

49737 Structuring a small national or state solar energy program. Jones, W.H. (Univ. of West Florida, Pensacola); Yarosh, M.M. pp 165-172 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A framework was constructed, relating phase of solar implementation to maturity of solar technology. Priorities were established in the phases of system analysis, research and development, demonstrations, standards and testing, commercialization, and education and information.

49738 State of solar technology developments in the Federal Republic of Germany. Wallner, I. (German Solar Energy Industries Association, Essen). pp 173-174 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Solar energy technologies enable the direct, as well as the indirect utilization of solar energy. In the meantime, 22 firms, many of which are known world-wide, have joined together in the German Solar Energy Industries Association (ASE); their goal is to further the research, testing and development of possibilities for utilizing solar energy. These companies have begun manufacturing and delivering all components for solar facilities, as well as complete systems, or these firms provide the know-how for utilizing solar energy in the following areas: Domestic Hot Water, Heating, Space Cooling, Desalination, and Electricity Generation.

49739 Energy balances as a means for the evaluation of solar energy in developing countries. Cavard, D.; Criqui, P. (IEJE, Grenoble, France). pp 214-218 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The use of energy balances is studied for the construction of energy systems based on local and renewable energy resources in developing countries.

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 49633, 49767, 49798

49740 (COO—4577-7) **Optimization of photovoltaic/thermal collector heat pump systems.** Russell, M.C.; Kern, E.C. Jr. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1979. Contract EG-77-S-02-4577. 5p. (CONF-790541—20). P 02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Combined photovoltaic/thermal (PV/T) collectors convert insolation directly to both electrical and thermal energy. These collectors are potentially less costly and have smaller space requirements than equivalent separate collectors operating to satisfy residential heating, cooling, hot water and electrical power demands. TRNSYS simulation of PV/T collector-heat pump systems for residences in New York and Fort Worth climates, and analysis of the technical and economic results are discussed. The parallel heat pump configuration with 40 square meters of PV/T collectors was found to be the least-cost system option for the New York residence.

49741 (LBL—9315) **Infrared radiative cooling.** Berdahl, P.; Martin, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 5p. (CONF-790541—40). P 02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Measurements are reported of the thermal infrared radiance of the sky, at Tucson, AZ; San Antonio, TX; and Gaithersburg, MD. The spectral resolution is approximately 2 microns in the range of 8 to 20 microns. Samples of data show that a computer model of the atmosphere is capable of approximate prediction of the measurements if the meteorologic state of the atmosphere is completely known. Data for Gaithersburg and Tucson exhibit a correlation between the 8.1 to 13.7 micron radiance of the zenith and the all-wave (4-40 micron) radiance of the entire sky. This correlation suggests that it will become possible to use pyrgeometer data to estimate spectral radiation from different parts of the sky. The new information concerning infrared sky radiance obtained from the current measurements can be applied to improved estimates of infrared heat transfer from (i) passive radiative cooling systems, (ii) the outer glazing of solar collectors, and (iii) the external skin of buildings.

49742 (LUTMDN/TMVK—3065/1-12(1978)) **Central receiver solar heating systems.** Hammer, T. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Kraftteknik). Jul 1978. 15p. U 02/MF A01.

A simple computer model has been developed in order to calculate systems for solar heating of houses in connection with an auxiliary heat source and a storage tank.

49743 (SERI/TR—34-090) **Simulations and economic analyses of desiccant cooling systems.** Shelpuk, B.C.; Hooker, D.W.; Jorgensen, G.J.; Bingham, C.E. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1979. Contract EG-77-C-01-4042. 197p. P 09/MF A01.

The progress to date in the development and analysis of computer simulations of solar-powered desiccant cooling using an axial-flow disc-type dehumidifier wheel, solar-powered space heating, and electrically driven, standard vapor-compression air-conditioning systems for residential use is documented. Computer simulations for both solar and conventional heating and cooling systems were performed for 12-month heating and cooling seasons. Annual thermal performance and the resulting life cycle costs for both types of systems were analyzed and compared. The heating/cooling season simulations were run for five U.S. cities representing a wide range of climatic conditions and insolation. With the informaion resulting from these simulations, the optimum air-conditioning system was chosen to maximize the conservation of fossil fuels and minimize operating costs. Because of the increasing use of residential air conditioning employing electrically driven vapor-compression coolers, the five locations were studied to determine if it would be beneficial (in terms of both economics and fossil fuel displacement) to displace fossil-fuel-powered vapor-compression coolers and natural gas space heaters with solar-powered heating and desiccant cooling systems.

49744 (SIB-R—12-1979) **Energy from solar heated air in garrets for water heating and for preheating of ventilating air. A pilot study.** Abrahamson, T. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1979. 23p. (In Swedish). U 02/MF A01.

The possibilities to use the energy from solar heated air in garrets for water heating and for preheating of supply air have been experimentally investigated. The roofs of the studied houses were made of wood and were covered by concrete tiles. The aim was to utilize the concrete tiles and the roof as natural solar collectors for the preheating of air. In one of the studied houses the air will be used as a source of heat for a heat pump establishment for domestic water heating. The results from this investigation show that the costs of installation for such a system with a heat pump will be much lower than for a solar collector set-up giving the same energy conservation.

49745 (SOLAR/0801—79/01) **Architectural concerns in solar system design and installation.** Weinstein, S. (Ehrenkrantz Group, New York (USA)). Mar 1979. Contract EG-77-C-01-2522. 34p. P 03/MF A01.

This report articulates the physical (rather than the mechanical or electrical) aspects involved in the design and installation of solar systems. It also addresses the typical physical factors and problems encountered in design. In addition, it comments upon the cost effectiveness of various approaches. This report discusses design characteristics of the collector and storage loops, using existing technology, and is unrelated to the specific application of the solar energy collected (i.e., the demand loop - whether domestic hot water (DHW), heating, or cooling - is not covered in this report). Rather, it discusses DOE's specific experience relative to what solar designers nationwide are designing in the installation of solar collectors, array structures, piping and storage equipment, with particular emphasis on cost-effective alternatives.

49746 Free convective laminar flow within the Trombe wall channel. Akbari, H.; Borgers, T.R. (Univ of Calif, Lawrence Berkeley Lab). *Sol. Energy;* **22**: No. 2, 165-174(1979).

Free convective laminar heat transfer between the channel surfaces of the F. Trombe wall has been investigated. Considered in this study were the velocity profiles normal and parallel to the direction of fluid flow, the pressure drop due to flow acceleration at the channel entrance, and the effect of dissimilar but uniform channel surface temperature for a wide range of flow rates and temperatures. A finite difference procedure was used to solve the governing equations in dimensionless form using air as the fluid. After comparison with available experimental data, results have been reduced, and several correlations developed to enable important performance characteristics to be estimated given the channel thickness, height, and surface temperatures.

49747 Construction of combined solar plants for heating and cooling supply. Bairamov, R.; Davletov, A.; Sokolov, A.F. (Physical-Technical Inst., Ashkhabad, USSR). *Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol. Nauk;* No. 2, 54-60(1979). (In Russian).

The comparative calculations made for solar water heaters and paraboloid cylindrical concentrators corroborate the efficiency

of their use for heating and cooling of houses within the areas which have the same climatic conditions as the station Beki-Bent.

49748 Energy savings for a solar heated and cooled building through adaptive optimal control. Farris, D.R.; Melsa, J.L. (Univ of Calif, Los Alamos Sci Lab, NM). *Proc. IEEE Conf. Decis. Control;* No. 78, 206-213(1978).

A study of the applicability of adaptive and optimal control techniques to the control of heating, ventilating, and air conditioning (HVAC) systems of solar heated and cooled buildings is described. The suitability of optimal and adaptive concepts is discussed and the selected approach is explained. An integral quadratic cost functional to define optimal performance and an identification process to produce a linearized building model are combined to yield an adaptive linear regulator solution. The building model is described and heating system simulations of three versions of the adaptive optimal controller are reported along with a simulation of a conventional controller for comparison. 17 refs.

49749 Solar: bibliography. Hamilton, B. (comp.). Butte, MT; National Center for Appropriate Technology (1978). 16p. (NP—23822).

This annotated bibliography lists books, pamphlets, and plans of general interest in solar energy.

49750 United States solar heating and cooling R and D program. Morse, F.H. (Energy Research and Development Administration, Washington, DC). pp 74 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The program plan is based on ten different approaches (paths) to the use of solar energy to meet the heating and cooling needs of buildings. Two service hot water paths have been identified, one using flat-plate liquid-heating collectors and the other using flat-plate air heating collectors. Four space heating paths were selected: direct solar heating of space or structure, solar-assisted or solar-powered heat pump using a variety of collectory types, heating with flat-plate air-heating collectors, and heating with flat-plate liquid-heating collectors. Four space cooling paths were identified: evaporative cooling, night-sky radiation or cool night air without additional energy conditioning equipment, concentrating collectors with absorption or Rankine-vapor compression chillers, advanced, non-concentrating collectors with absorption or Rankine-VC chillers (operating at moderate temperatures) and flat-plate collectors with desiccant chillers.

49751 Solar energy activities in Austria. Faninger, G.; Bruck, M. (Austrian Solar and Space Agency, Vienna). pp 75-78 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

In Austria, research in the field of solar energy has been done for two years now. Solar heating systems have been developed and tested for their application for swimming pool heating, domestic water heating and space heating. At present mainly economic aspects determine on which R and D activities in the field of solar technologies for the production of heat the emphasis is to be laid. However, research is also done in areas of solar energy utilization which technologically are not yet mature.

49752 Utilization of solar energy at a low-temperature range. Part 1. Solar collectors and utilization of them for domestic water and swimming-pool water heating as well as space heating. Gnugesser, E.; Mukherjee, S.K. pp 180-186 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The authors first treat meteorological data and subsequently the construction of solar collectors. In the following, various plant systems are described by examples. An introduction is given to calculation methods to be applied for giving details on the economical operation of solar plants.

49753 Solar energy and the second law of thermodynamics. Kreider, J.F. pp 224-228 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

One of the unique and technically most attractive features of solar energy from a thermodynamic viewpoint is the feasibility of matching its means of collection to a broad range of tasks which operate over a large range of temperatures. It is the purpose of this paper to quantitatively describe this feature of solar energy and to provide an analytical framework for matching the means of solar energy collection to the task to be performed. A comparison between solar and non-solar enegy resources is made from a second-law viewpoint.

49754 Economic evaluation and optimization of solar heating systems. Brandemuehl, M.J.; Beckman, W.A. (Univ. of Wisconsin, Madison). pp 239-247 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Life cycle cost analysis is used to evaluate economic comparisons between residential solar heating systems and conventional heating systems. The comparison is expressed as the life cycle savings of the solar system over the conventional system. A procedure which simplifies the life cycle cost comparison is developed by introducing two economic parameters, P_1 and P_2. These parameters relate all life cycle considerations to the first year fuel savings or the initial solar system investment cost. Assuming a linear relationship between the solar system investment cost and the collector area, the simplified savings equation is optimized with respect to collector area. Using the f-chart design method, tables are generated which give the optimum collector area to annual load ratio, and the optimum load fraction supplied by solar energy, as a function of this economic parameter. This non-iterative optimization procedure is applied to a standard domestic water heating system, a combined space and domestic water heating system with air as the transfer-medium, and a combined system with liquid as the transfer-medium.

49755 Solar energy, architecture and public acceptance in developing countries. Talib, K. (Univ. of Lagos, Nigeria). pp 294-300 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Two residences were designed for two distinctive climatic conditions of the tropics namely Warm Humid and Hot Dry. Both buildings attempt to use passive climatic controls and building techniques traditionally available in various parts of the world. Both buildings are in stage of working design.

49756 Solar energy system with a dual-source heat pump and long-term storage. Hewitt, E. (Solar Associates, Hartford, CT); Raman, K. pp 463-469, 470a-470b of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The performance and economics of a solar energy system with a dual-source heat pump and long-term storage are discussed. Results are presented for the collector and storage sizing, and the variation of the life cycle costs as a function of the various system parameters. The special role of the collector performance and the price of electricity in determining the optimum range of collector and storage sizing are pointed out. The advantages of the type of solar-assisted system considered here are summarized.

49757 Investigation on the feasibility of using a two-phase thermosyphon for solar storage, space heating and cooking. Bhattacharya, S.C. (Univ. of Agriculture and Tech., Pantanagar, India); Kapur, V.K. pp 579-582 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Since solar energy is essentially collected outdoors and is generally utilized indoors, the need for some sort of energy transport exists. In this paper the feasibility of using a two-phase thermosyphon for this purpose has been considered and the results of an experimental thermosyphon have been reported.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 49749

49758 (ORNL/Sub—7525/3) STES applications model (SAM) user's guide. Timmer, A.M. (Aerospace Corp., El Segundo, CA (USA). Electronics and Optics Div.). 4 Jan 1979. Contract W-7405-ENG-26. 131p. (ATR—79(7748)-3). P 07/MF A01.

This document is a user's guide for the STES Applications Model (SAM) which can be used to identify industrial applications which are good candidates for Solar Total Energy Systems (STES). SAM computes and ranks equivalent cost ratio and calculates fuel displacement potential by geographic location (50 states) and by industrial application (140 three digit SIC categories) for seven time periods (from 1985 to 2015 in five year increments). SAM is written in FORTRAN for the FTN compiler on the CDC 7600 computer.

49759 Comparison between sun and wind as energy sources in irrigation plants. Gaia, M.; Macchi, E. (Politecnico di Milano, Italy). pp 265-272 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The mechanical power needed for irrigation pumps can be obtained from two renewable sources of energy, wind and sun. In order to investigate the construction costs, the engine performance at various loads and the reliability, two prototypes of Rankine cycle engines using tetrachloroethylene as the working fluid were built, having a power output of about 4 kW. Engine data and measured performance are reported. Optimum collecting temperatures for cylindro-parabolic collectors and flat-plate collectors associated with organic fluid engines are discussed. Thereafter engine costs for 10 kW and 100 kW units are extrapolated. A 4 m diameter Darrieus wind turbine was also built and the cost for small series production was computated as a function of turbine diameter.

WATER HEATING

REFER ALSO TO CITATION(S) 49633, 49740, 49744, 49747, 49749, 49751, 49752

49760 Determining installed costs of the SAGE system. Schoen, R. (Solar Resources, Inc., Los Angeles, CA); Furman, D. pp 263-264 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An intensive study is being conducted of the installed cost for SAGE solar-assisted hot water heating systems for multifamily apartments. The study is using cost figures from seven projects. Efforts are currently underway to compare and parameterize these total costs as installed and/or projected as well as to break down and compare their component labor and material elements. At the same time, related SAGE tasks will be drawn on to attempt to disassociate costs of the installed systems into various kinds of cost characteristics.

49761 Understanding the US construction industry: an integral task of the SAGE solar commercialization project. Schoen, R. (Univ. of California, Los Angeles). pp 315-326 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

From its beginning in 1973, SAGE has been a multi-disciplined investigation into technical, economic, and institutional requirements for successful commercialization of Solar-Assisted Gas Energy for domestic hot water heating in low-density multi-family housing. As one aspect, studies began early of the structure of the US Construction Industry, the roles of its key actors, and their attitudes towards technological innovation. These investigations have ensured that the two SAGE demonstration installations involved appropriate industry participants and were viable in its terms. Results from these demonstrations and the on-going industry studies were combined to create utilization requirements. UR's are believed to be system characteristics essential for successful commercialization of solar technology in southern California. This paper reports on the findings of these industry studies and the process by which they have been utilized by Project SAGE.

49762 Development and testing of an improved built-in storage solar water heater. Garg, H.P.; Mann, H.S.; Thanvi, K.P. (Central Arid Zone Research Inst., Jodhpur, India). pp 566-570 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A simple, low cost and portable solar water heater with built in storage system employing an openable and adjustable reflector-cum-insulation cover on the lower side and polished aluminium reflectors on the other three sides suitable for the year round use in rural as well as in urban areas is described. This heater supplies 90 litres of water at temperatures in the range 50 to 60°C on winter afternoons and 60 to 75°C on summer afternoons. The cost of this solar water heater is about Rs.450/- and the thermal energy obtained with the heater is about 9 paise/KWH.

OTHER

REFER ALSO TO CITATION(S) 49757

49763 (DOE/TIC—10140) Materials considerations relevant to solar heating of chemical reactions. Tennery, V.J.; Tiegs, T.N. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. P 02/MF A01.

Results of a preliminary assessment of the equilibrium thermodynamic stability of a number of ceramic materials for use in solar chemical process heat receivers are given and discussed. The process considered were: (1) hybrid bismuth sulfate cycle for H_2 production; (2) cadmium oxide cycle for H_2 production; and (3) nitrogen fixation from air for fertilizer production. MgO appears to be the best material for use with the hybrid bismuth sulfate and nitrogen fixation cycles, although the ZrO_2 (Y_2O_3) ceramic could possibly be used with the hybrid bismuth sulfate cycle. Confirmatory testing of these predictions are planned at ORNL. Since no appropriate thermodynamic data were available for the cadmium cycle, no equilibrium reaction predictions could be made. Testing of candidate materials with components of the cadmium oxide cycle are required and such tests are scheduled for initiation during FY 79. (WHK)

49764 (SAND—79-8187) Technical and economic assessment of solar powered water pumping for remote areas. Final report. (Bechtel National, Inc., San Francisco, CA (USA)). Jul 1979. Contract EY-76-C-04-0789. 110p. P 06/MF A01.

The technology of solar powered water pumping is reviewed. An overview of the technology and its economics is provided, based on a review and assessment of the open literature. It is shown that pumped water is used most extensively for irrigation, and that new irrigation methods, such as the center pivot system, have significantly increased the water pumping power demand in recent years. The coincidence of the peak irrigation season and peak seasonal insolation makes solar energy a good candidate to supplement or displace depletable energy sources currently used for water pumping. Solar powered water pumping demonstration systems utilizing solar thermal, photovoltaic and wind powered energy conversion. The prime movers of these systems either drive the pumps directly or indirectly through electric power generation. A comparative evaluation of these and other proposed solar concepts was conducted and resulted in the selection of a reference system comprised of a number of individual parabolic dish collectors with integral Brayton cycle engines. This reference system provided a basis for economic comparisons with a typical conventional electric pumping system. It was determined that the cost of power from the reference solar concept will probably not break even with present-day utility-powered pumping systems until at least the turn of the century.

49765 Cooking with stored solar heat. Hall, C.A. (Martin Marietta, Denver, CO); Swet, C.J.; Temanson, L.A. pp 547-553 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The system would have two basic elements: an outdoor central solar heater, shared by the families and consisting basically of a lens to concentrate the sun's heat, and a heat package owned by each family to store the heat until ready for cooking. The central solar heater would consist of a plastic strip in the form of a Fresnel lens. This strip would be mounted on a frame of a length sufficient to cover the number of heat packages needed. The heat packages will contain a chemical system capable of absorbing energy from the sun, storing it, and releasing the heat on demand at a temperature near 300°C. The choice of a chemical system will be guided by the results of research and development tests recently completed. A possible candidate is the ammoniated salts of magnesium chloride and calcium chloride.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 49707

49766 (ALO—5308-T2) Polymer surface coatings for downconversion of uv radiation and inhibition of photodegradation. Yen, W.M.; Yu, H. (Wisconsin Univ., Madison (USA)). 1978. Contract EM-78-C-04-5308. 12p. P 02/MF A01.

The objective is to develop and evaluate the surface coatings on polymeric substrates which will downconvert the uv component of solar radiation into the visible or IR region and will simultaneously inhibit photodegradation of the plastic glazings. Cerous ion (Ce III) and other trivalent lanthanide ions are known to downconvert uv radiation into visible or IR owing to their low-lying electronically excited states. Thus plastic glazing substrates overcoated with these ions in sufficient concentration are expected to be resistant to the photodegradative effect of the uv component of the solar spectrum. Cerous (III) polymethacrylate (CPMA), prepared by saponifying a commercial polymethyl methacrylate (PLEXIGLAS) and subsequently neutralizing with cerous nitrate, were cast into film from its ethyl acetate solution. CPMA films were subjected to an intense uv radiation in order to accelerate the solarization, and they were found to be substantially less susceptible to uv induced degra-

dation than the control which was the film cast from polymethacrylic acid (PMA). A set of CPMA coated PLEXIGLAS films were then tested by the same method and the films with coating thickness of 5μ were inhibitory toward the uv degradation although the surface density of cerous ion was not uniform. A solar simulator has been assembled and calibrated. It has begun to test a series of CPMA coated PLEXIGLAS films.

49767 (BNL—50974) **Solar-powered steam generator heliostat. Final report.** Cottingham, J.G. (Brookhaven National Lab., Upton, NY (USA)). Dec 1978. Contract EY-76-C-02-0016. 143p. P 07/MF A01.

A small-size central-receiver-type solar energy collecting system delivering commercial grade steam is analyzed and a wind avoidance type heliostat designed, built, and successfully tested. The heliostat design effort is described, including reflecting surface materials and measurements, optic considerations and mirror field arrangements, mechanical analysis and fabrication techniques, and economics and cost effectiveness. Measurements of normal incident solar energy at Upton, N.Y., are reported and a method is proposed for estimating this input parameter for other locations proposed.

49768 (CONF-7610164—1) **Inside-mirrored rotational funnel as a concentrating solar collector.** Kleinwaechter, H. (Cooperation Mediterraneenne pour l'Energie Solaire, Marseille (France)). 1976. 16p. (CONF-7609207—1). U 02/MF A01.

From Symposium on the applications of solar energy; Teheran, Iran (Oct 1976).

Portions of document are illegible.

The development, the prototypes and the first results with this type of collector are discribed. It consist of a inside mirrored funnel which concentrates as a function of its special geometry the solar rays on an area with a homogeneous or other desired distribution. The collector is designed to produce steam of over 500° Kelvin and 15 bar of pressure, to drive pumps, electric power stations, water-desalination plants and absorption chillers. The reflector, its construction, the solar tracking system and the absorbent surface with its optimization and selectivity are described.

49769 (COO—2934-7) **Study of corrosion and its control in aluminum solar collectors. Annual report, June 1, 1977—July 31, 1978.** Wong, D.; Cocks, F.H.; Giner, J.; Majahad, P.S. (Giner, Inc., Waltham, MA (USA)). Aug 1978. Contract EY-76-C-02-2934. 68p. P 04/MF A01.

The development of corrosion control methods for aluminum solar collectors using ethylene glycol heat transfer fluids was studied. Corrosion inhibitors and impurity scavengers have been tested and evaluated at temperatures up to 160 C under various laboratory conditions. A new corrosion rate measurement technique based on the use of thin foil samples was developed and adopted in this program to provide accelerated results. In addition to the development of corrosion control methods, the acquisition of baseline corrosion data was also extended to the aluminum/propylene glycol combination. Propylene glycol was chosen primarily because of its low toxicity. Aluminum corrosion characteristics were determined in 50, 85 and 100% propylene glycol solutions at temperatures between 25 to 160 C. Corrosion behavior of aluminum in more concentrated ethylene glycol solutions (up to 100%) at higher temperatures (up to 160 C) was also obtained in order to broaden the baseline. The cube root pit growth law was also verified experimentally. All the parameters needed to predict the time to plant failure due to pitting perforation were also determined. With regard to the aluminum/propylene glycol combination, aluminum alloys were found to be about ten times more corrosion resistant in propylene glycol than in ethylene glycol solutions under similar conditions. An extensive literature review showedthat phosphates, borates, nitrates and silicates and sodium mercaptobenzothiazole are effective corrosion inhibitors which are compatible with glycol solutions. It was determined that most inhibitor formulas, whether proprietary or prepared in-house, can reduce the overall aluminum corrosion rate to below 1 mpy at temperatures below 100 C.

49770 (COO—4657-1) **Fundamentals and techniques of non-imaging concentrators for solar energy. Progress report, January 1—September 30, 1978.** (Chicago Univ., IL (USA)). 1978. Contract ER-78-S-4657. 16p. P 02/MF A01.

Summaries of theoretical activities are given including: (1) solution for ideal solar concentrators with reflector gaps; (2) development of a new formalism for non-imaging optics; and (3) properties of asymetric ideal concentrators. Experimental activities summarized include: (1) fabrication of lab model for tubular absorber with reflector gaps; (2) optical losses of a segmented approximation to a 5XCPC with mirror gaps; (3) self-contained evacuated glass concentrator—absorber; and (4) survey of diffuse radiation and its long-term correlation with standard hemispherical insolation data. (WHK)

49771 (IS-M—202) **Photothermal conversion surface measurements using photoacoustic and photothermal spectroscopies.** McClelland, J.F.; Kniseley, R.N. (Ames Lab., IA (USA)). 1978. Contract W-7405-ENG-82. 31p. (CONF-780550—10). P 03/MF A01.

From Seminar on testing solar energy materials and systems; Washington, DC, USA (22 May 1978).

Photoacoustic and photothermal spectroscopic techniques have recently been under development in a number of laboratories. When applied to solar materials studies these techniques have the potential of providing a more direct measurement of photothermal conversion efficiency than conventional reflection or transmission measurements. Measurements are made by modulating the intensity of an incident light beam which causes a temperature oscillation in the irradiated material under study with the oscillation amplitude proportional to the absorbed and subsequently thermalized light energy. In the photoacoustic method the oscillation amplitude is measured by a transducer which detects an acoustical signal driven by the temperature oscillation. A thermal transducer is used as the detector in the photothermal technique. Spectral or integrated measurements are made using a monochromatic or broadband source with no correction needed for the spectral dependence of a detector since the signal is generated by the interaction of light with the sample rather than with a detector. This allows spectrally integrated surface absorptivities to be measured directly, without integration of data, using a solar simulator, natural sunlight, or a blackbody source, with the latter operated at a temperature of interest for IR emissivity studies. Calibration methods currently being developed include standard surfaces and Joule heating based on electrical standards. Experimental set-ups are described.

49772 (LUTMDN/TMVK—3068/1-30(1978)) **Flat-plate solar collectors. Influence of design material and configuration on performance.** Ransmark, S.E. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Kraftteknik). Aug 1978. 31p. U 03/MF A01.

The rate of useful energy which can be collected from a flat-plate solar collector depends on many factors, such as: the absorptance/emittance factor of the absorber, its heat conductivity, the heat capacitance of the collector, the mass flow rate, and the velocity of the fluid. If, for instance, the number of risers in the absorber is increased a larger part of the absorber surface will be chilled directly by the fluid, and consequently the mean temperature of the surface, and thereby also the heat loss, will decrease. On the other hand, an increased number of parallel risers, for a given mass flow rate and a given pipe diameter, reduces the velocity of the fluid, which in turn causes a poorer heat transmission between plate and fluid. If the number of parallel risers is increased beyond a certain number, the useful gain per m^2 from the collector will no longer increase. Instead, the heat capacitance of the collector will increase, which is a disadvantage in areas where climate conditions are unfavourable due to variable cloudiness. The optimum number of risers will be different for different absorber materials. For cases with variable values of insolation, mass flow rate, and temperature levels the efficiency of the solar collector is computed for absorbers of steel, aluminium, copper, and polyeten plastic. Also, riser diameter and number of risers are varied. Attention is further paid to variations in circulation pump power as well as demands concerning the possibility of removing air from the absorber risers at various pipe diameters.

49773 (RFP—2896) **Co-sputtering of aluminum—silver alloy mirrors for solar reflectors.** Adams, R.O.; Nordin, C.W.; Fraikor, F.J.; Masterson, K.D. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant; Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EY-76-C-04-3533. 12p. (CONF-790442—1). P 02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Apr 1979).

Portions of this document are illegible.

Producing films of aluminium—silver alloys of various compositions for evaluation as solar reflectors is reported. The objective is to produce a substrate coated with aluminium and silver varying in composition from one end to the other. The films are characterized metallographically and compositionally, then the reflectivity and corrosion problems are determined. (MHR)

49774 (SAND—78-2047C) **Specular reflectance properties of solar mirrors as a function of incident angle.** Glidden, D.N.; Pettit, R.B. (Albuquerque Academy, NM (USA); Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 5p. (CONF-790541—29). P 02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

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The specular reflectance properties of several solar mirror materials have been measured as a function of wavelength, polarization and incident angle. Results for a 3-mm thick, silvered float glass mirror and an aluminized acrylic stretched film are presented. For the silvered glass mirror, measured specular and hemispherical reflectance properties are in excellent agreement with reflectance values calculated from a multiple beam reflectance model. At 65° from normal, the average solar reflectance is decreased only ~ 4%

from the value at normal incidence. For the aluminized acrylic mirror, measured specular reflectance values at 15 mrad were in agreement with hemispherical reflectance values, while calculated reflectance values are as much as 2% high for one polarization. The average solar reflectance decreases only 2% at an incident angle of 65° from normal, while the width of the specular beam increases slightly with incident angle.

49775 (SERI/TP—31-193) **Long-term glazing performance.** Jorgensen, G.J. (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 12p. (CONF-790667—1). P 02/ MF A01.

From Solar glazing: 1979 topical conference; Pomona, NJ, USA (22 Jun 1979).

Portions of document are illegible.

A survey of glazing materials is presented and initial (nondegraded) properties are compared. Weathering characteristics are discussed in terms of mechanisms and their effects upon candidate glazings. Examples of failure modes are given for various commercially available materials. A specific process, optical degradation, was studied in detail to determine how loss of solar transmission affects the thermal performance of flat-plate solar energy collection systems. Computer simulations of singly and doubly glazed collectors having cover plates of various commercially available transparent materials were made for one-week time periods using Phoenix, Ariz., insolation and meteorological data. Optical degradation was modeled by systematically decreasing the specified values of solar transmittances of the plastic cover plates under consideration. Energy collection efficiencies corresponding to each decrement of transmittance were normalized to that of nondegraded glass to allow comparisons both with a standard and among the different plastics. This provides a measure of the relative usefulness of various candidate polymeric glazing materials when realistic rates of optical degradation are known.

49776 Solar heating and cooling collector window. Medico, J.J. Jr. US Patent 4,144,931. 20 Mar 1979. Filed date 23 Aug 1976. 4p.

This invention comprises a solar unit in the form of a window having a plurality of vanes extending there-across connected for unitary pivotal movement relative to the frame, together with means for adjusting the vanes for the collection of solar heat in utilizing such heat to heat water or air circulated through pipes carried by the vanes and connected to suitable headers at each end of the vanes or adjustment of the vanes to permit air and light to enter the enclosure in a wall of which the window collector is mounted and to permit circulation of cold water or air through the pipes extending through the vanes to cool the interior of the enclosure, as well as to permit adjustment of the vanes in such manner as to, in effect, to close the window from the outside of the enclosure from the outside atmosphere enveloping the enclosure, and to position the vanes in such manner as to augment either the heating or cooling of the enclosure as desired.

49777 Experimental investigation of temperature field of thin-walled sheathing of the paraboloid reflector. Bairamov, R.; Baum, I.V.; Li, B.; Machuev, Yu.I. (Physical-Technical Inst., Ashkhabad, USSR). *Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol. Nauk;* No. 2, 50-53(1979). (In Russian).

The maximal temperature values and overfall along the paraboloid surface have been determined. The heat transfer coefficient is a first approximation related with wind velocity by a linear regularity, the difference between calculated data and experimental ones does not exceed 2 to 4°. The range of the paraboloid surface's optical characteristics is given.

49778 Compound paraboloid radiant-energy collectors. Paderin, L.Ya. (Central Aerohydrodynamic Inst., Moscow, USSR). *Geliotekhnika;* No. 5, 45-51(1978). (In Russian).

A study is made of axisymmetrical paraboloid compound-mirror concentrators collecting solar radiation which arrives parallel to the axis of the concentrator. Assuming that the radiation flux from the entire surface of the sun is uniform, a study is made of the capabilities of such collectors, which consist of rings of flat or spherical-section mirrors arranged on a paraboloid surface. It is concluded that spherical rings are much more efficient in the collection of solar radiation than are flat (conical section) rings. 3 references, 4 figures.

HEAT STORAGE

REFER ALSO TO CITATION(S) 49655, 49765

49779 Long-term thermal storage in solar architecture in northern latitudes, with reference to typical single family dwellings. Michaelis, D. (Solar Energy Developments, London, England). pp 471-473 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

In the past few years a prototypical solar house has evolved. For a useable floor area of 80 to 100 m^2 it is equipped with 20 to 50 m^2 of solar collectors linked to thermal stores normally consisting of 2 to 5 m^3 of water or 10 to 20 m^3 of rockbed storage. These are short-term storage systems principally ensuring day to day carryover.

49780 Long-term storage of solar energy in native rock. Riaz, M. (Univ. of Minnesota, Minneapolis). pp 474-479 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Long-term storage (annual or seasonal storage) of solar-collected thermal energy in native rock or sandstone appears to be both technically feasible and economically attractive. In this storage concept, a large bed of crushed or naturally formed porous rock is heated by hot air flowing from a central manifold to two cold manifolds; on discharge, the flow is reversed and cold air, introduced at the top and bottom manifolds, is heated in passing through the porous media so that hot air can be harvested at the central manifold. The paper discusses some of the basic factors and constraints which govern the performance of such earth thermal storage units and evaluates several possible construction methods of interest from which a storage cost assessment can be made.

49781 Solar energy earth storage and utilization: technical and economic aspects. Yuan, S.W.; Bloom, A.M. (George Washington Univ., Washington, DC). pp 480-481 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper presents the concept of earth storage with the ability to store solar energy for long duration which can later be used during winter months for both space and water heating in homes. The earth, as a thermal storage reservoir, has several interesting attributes. First, heat capacities are large because of the large available mass. Another attribute of the earth is its comparatively low thermal conductivity. This allows the operation of the earth storage system without thermally insulated boundaries in the downward and sideward directions as the relative low thermal conductivity of the earth limits to a minimum heat losses in these directions, especially when the thermal storage system is saturated after a few seasons.

49782 Energy storage requirements for autonomous and hybrid solar thermal electric power plants. Iannucci, J.J. (Sandia Labs., Livermore, CA); Smith, R.D.; Swet, C.J. pp 482-486 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This work originated as a study of the costs and benefits of using seasonal chemical energy storage as part of a STEC plant which is to meet a specified demand profile. The cost of electricity from such an autonomous solar plant is compared to that of a solar plant with alternate energy-backup, i.e., a hybrid solar plant. The alternate energy backup can be provided by an on-site combustion turbine or purchased from a utility whenever necessary. The cost of this alternate energy is balanced against the economics of the STEC plant to determine the optimum (i.e., minimum BBEC) solar/backup mix of the hybrid, and further, the storage requirements at that mix. Because a great deal is known about the ($SO_3/SO_2/O_2$) reactions from experience in the chemical industry, a chemical energy storage system using these reactions was designed.

49783 Thermal storage in chemical bonds. Lilleleht, L.U.; White, C.W. (Univ. of Virginia, Charlottesville). pp 487 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The purpose of this paper is to explore the feasibility of using various chemical reactions for thermal energy storage. After establishing the desirable thermodynamic and other characteristics, the kinetics of candidate reactions will be considered leading to a set of guidelines for CCM selection. These guidelines will then be applied to several types of chemical reactions.

49784 Chemically driven heat pumps for solar thermal storage. Offenhartz, P.O.D. (EIC Corp., Newton, MA). pp 488, 489a, 489b of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Methods of storing solar thermal energy by means of chemical reactions in heat pump cycles are reviewed. These chemical reactions involve one or two solid (or, in one case, liquid) substrates plus a carrier gas. Charging the system involves decomposing a solid (or liquid) complex into a solid (or liquid) plus a gas; the gas in turn liquefies under pressure - or reacts with a second substrate - at a lower temperature. Discharging the system involves boiling the liquid (or decomposing the second substrate-gas complex) at a low temperature and reforming the original complex at a temperature suitable for heat exchange. In this way heat is pumped on discharge from a low temperature source (ambient air or an underground reservoir) to a higher temperature; storage and heat pumping are inseparably involved. Six different systems sponsored by the US DOE are noted; the major potential obstacles and performance advantages are discussed. Most of the systems show promise for solar air conditioning as well as for thermal storage and heat pumping. Some should be capable of delivering more heat than input via the solar collector, thus reducing solar collector size (and cost).

49785 Underground aquifer storage of hot water from solar energy collectors. Tsang, C.F.; Lippmann, M.J.; Witherspoon, P.A. (Univ. of California, Berkeley). pp 490-494, 495a, 495b of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A study has been made on the physical feasibility of using underground aquifers as a storage system for hot water from solar energy collectors. Two different numerical models were used in this study. The first is a sophisticated program that computes the transient heat and mass flow in three dimensional water-saturated porous media. The second is a simplified model which considers a horizontal two-dimensional aquifer in which steady state fluid flow is assumed. Four cases were considered: a) daily storage, b) seasonal storage with semiannual cycles, c) seasonal storage with annual cycles, and d) a two-well (doublet) system, in which one well supplies the water to be heated by solar energy and the other well stores the heated water underground. The hydrodynamic and thermal behavior of the storage system was analyzed and illustrated. In all cases studied, the energy retrieval was found to be over 80 percent.

49786 Simulation study of phase change energy store. Rajagopal, K.; Ong, T.H. (Federal Univ., Rio de Janeiro, Brazil). pp 496-499 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Heat transfer to a phase change material in a cylindrical annulus was studied experimentally. Heat is transferred through the outer wall of the annulus with a circulatant fluid. Different flow rates and inlet temperatures were used in both cooling and heating. The temperature histories in the material during heating showed interaction of transient conduction and natural convection. Heat transfer rate during heating is convection-controlled with main resistance in the molten material. Cooling is controlled by transient conduction. The experimental results are correlated using simple convection correlations. These results are useful in the design of phase change thermal storage system.

49787 Investigation of physical and chemical properties of phase change materials for space heating/cooling applications. Heine, D.; Abhat, A. (Univ. of Stuttgart, Germany). pp 500-506 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The physical and chemical properties of four paraffins (different oil contents), a wax-ester, a fatty acid and two inorganic salts are experimentally investigated. Heating and cooling curves for the materials are obtained and their compatibility with four conventional metals of construction - stainless steel 1.43O1, Cu 99.9, Al 99.5 and AlMg3 - determined. While all organic substances are found non-corrosive, only one paraffin with 5% oil content and lauric acid exhibits good freezing characteristics. The two inorganic salts suffer from acute supercooling. Moreover, $Na_2S_2O_3.5H_2O$ is found to be corrosive against Cu and $Na_2HPO_4.12H_2O$ strongly corrosive against aluminum and its alloy AlMg3.

49788 Considerations in the use of solid-solid phase transitions for thermal energy storage. Leffler, A.J.; Weinstein, D.I. (Villanova Univ., PA). pp 507-510 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The existence of a group of crystals that exhibit polymorphism, the presence of two or more distinct and stable lattice symmetries, has been known for some time. However, only in the last fifteen years has much effort been directed to the characterization of these solids in terms of their unique physical properties. Our research is directed first, at expanding the list of known polymorphic solids that undergo a solid-to-solid transition above room temperature, and second, in using these solids in the storage of thermal energy.

49789 Phase change thermal storage for a solar total energy system. Rice, R.E.; Cohen, B.M. (Comstock and Wescott, Inc., Cambridge, MA). pp 511-515 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

An analytical and experimental program is being conducted on a one-tenth scale model of a high temperature (584 K) phase change thermal energy storage system for installation in the Solar Total Energy Test Facility of the Sandia Laboratories at Albuquerque, New Mexico, USA. The thermal storage medium is anhydrous sodium hydroxide with 8% sodium nitrate. The program will produce data on the dynamic response of the system to repeated cycles of charging and discharging simulating those of the test facility. Data will be correlated with a mathematical model which will then be used in the design of the full scale system.

49790 Passive integrated unit for the collection, thermal storage in fusion materials and distribution of solar energy for home heating and other applications. Kapur, J.C. (Kapur Solar Farms, New Delhi, India). pp 516-520 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Kapur Solar Farms, located in the Union Territory of Delhi, installed a solar energy plant for the heating of a farm house in the year 1968. The farm house with an area of approximately 1000 sq.ft. (100 sq. mts.) had a heating plant which consisted of 240 sq. ft. (24 sq. mts.) of solar collectors for the heating of water which was stored in an underground storage tank. The heat storage system consisted of a water storage tank surrounded by pebbles and heat was drawn from this system through a small centrifugal blower fan. In the winter of 1975—76, a panel incorporating a system for solar energy collection, storage in fusion materials and then distribution through natural convection, controlled through dampers, was installed. Still further improvements were effected in these units and six of the latest units have now been installed for further experimentation and approval in the winter of 1977—1978. The paper narrates experiences gained with these units.

49791 Development of thermocrete heat storage materials. Chahroudi, D. (Suntek Research Associates, Corte Madera, CA). pp 521-523 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Thermocrete is a heat storage media combining an appropriate phase change material with a concrete matrix resulting in isothermal storage, structural load bearing capability and good volumetric efficiency. Program goals and development progress are summarized, including performance and cost data. Future work is described.

49792 Theoretical and experimental analysis of a latent heat storage system. Benard, C. (ESE, Plateau du Moulon, France); Levesque, D.; Wirgin, A. pp 524-530 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The storage systems studied are collection-storage systems: the storage medium, the paraffin, is directly exposed to solar radiation through two glass panes. Short and long range behavior of the system is described.

49793 Low-cost solar energy storage regulation systems for raising young chickens in a subsistence-level economy. Benard, C. (ESE, Plateau du Moulon, France); Gobin, D.; Wirgin, A. pp 531-536 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The experimental chicken breeder that is studied here has been built in Andahuaylas (Peru). The construction started in July 76. Its capacity is of about one hundred chicks. The paraffin storage system is dimensioned (volume, surface area exposed to the sun) as a

function of the following considerations: (1) short range condition and (2) long range conditions.

49794 Thermal storage analysis on packed bed of alumina spheres. Asahina, T.; Kosaka, M. (Government Industrial Research Inst., Nagoya, Japan). pp 537-540 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A heat storage is one of the most important problems in solar energy systems. This paper dealt with heat transfer problems in a heat storage unit of packed pebble bed type and results of calculation were compared to those of experiments performed with a small scale alumina spheres heat storaging system.

49795 Performance studies of a finned heat pipe latent thermal energy storage system. Abhat, A. (Univ. . Stuttgart, Germany). pp 541-546 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Performance studies of a modular heat pipe heat exchanger concept for use in a latent thermal energy storage system for solar heating applications have been undertaken. The thermal analysis provides the influence of various geometric and thermal parameters on the storage charging time and temperature gradients for heat flow into two markedlly different storage substances. Additionally, experiments are performed with a small 6 l test model filled with a paraffin. Results indicate the capability of the heat exchanger concept to operate within small temperature swings (<10 K) for realistic heat input rates. Comparisons between data and prediction for the test model showed adequate agreement.

49796 Stratification effects in the short and long term storage of solar heat. van Koppen, C.W.J. (Eindhoven Univ. of Tech., Netherlands); Fischer, L.S.; Dijkmans, A. pp 554-558 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

The application of thermally stratified storage forms part of a broader strategy, which can be described as the conservation of energy. For space heating the lower temperature limit for the usefulness of any heat equals some 295 K (22°C). For the preheating of fresh intake air however, any heat at a temperature higher than the atmospheric one in winter may be put to use. These simple examples bring forward two important characteristics about energy: it depends not only on the state of the heat but also in the actual application one has in mind, and it may, at least partially, be conserved by using the heat at subsequently lower temperatures. Some examples are presented below.

49797 Use of monolithic structures for the short term storage of solar energy. Balakrishnan, A.R.; Silveston, P.L.; Sullivan, H.F. (Univ. of Waterloo, Ontario). pp 560-565 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

Monolithic structures represent an alternative to randomly packed beds of gravel for the short term storage of solar energy. These structures can be used in a non vertical position and can be shaped to fit space available in buildings. Pressure drops are lower for the same heat capacity of thermal performance. With the proper form choice, containers for the storage unit can be dispensed with. Whether or not the pressure drop saving will pay for the much greater cost of the storage material will depend on the material, its form, amortization rate and the cost of electric power.

49798 Passive rock bed: design, construction, and performance. Cook, J. (Arizona State Univ., Tempe). pp 571-573 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A passive rock bed has been completed for thermal storage in a house on an isolated mountainous site. A passive system of heat collection, storage, and distribution was only considered after an initial active system was designed, together with attendant back-up electric furnace. Among the chief reasons for the final choice of a passive system was the avoidance of fossil fuel consumption regardless of where; and the potential irregularity of electric service or any other fuel during times of need in a remote location. An air system was preferred by the owners to avoid the potential problems of wet systems. In addition, an air system would allow the house to be left unoccupied at any time of the year with all systems safely turned off.

49799 Study for optimum use of metallic plates for thermal storage in solar processes. Prasada Rao, C.V. (Ministry of Defence, Madras, India); Sastri, V.M.K. pp 583-587 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

A system with two metallic plates with a gap in between them is considered for study for optimum use as thermal storage medium. The performance of the systems of different sizes for different flow rates of charging fluid, different flow rates of charging fluid, different flow cross sectional areas and different metals is found and discussed. The economical charging times for different systems are given.

49800 Analysis of a thermal storage unit for solar energy. Sriramulu, V.; Ahmed, S.B. (Indian Inst. of Tech., Madras). pp 588-591 of Sun: mankind's future source of energy. Volume One. de Winter, F.; Cox, M. (eds.). Elmsford, NY; Pergamon Press Inc. (1978).

From International Solar Energy Congress; New Delhi, India (16 Jan 1978).

This paper focuses attention on the thermal storage unit for a solar power plant using a system of flat-plate collectors. The basic equations governing the processes occurring in the storage unit have been solved for an assumed load pattern. The effects of flow rate of working fluid through the load, stratification in the storage unit and the insolation on the performance characteristics have been studied. A control function simulates the switching on and off of the load and collector pumps. The collector pump is turned on if the collector output temperature is greater than the minimum temperature in the storage unit, otherwise, it is turned off. The temperature distribution in the storage unit changes with the flow rate of water. The effect of the storage volume on the overall performance appears to be small.

GEOTHERMAL ENERGY

NON-USA

REFER ALSO TO CITATION(S) 49822, 50194

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

49801 Lithic fragments in the Bandelier Tuff, Jemez Mountains, New Mexico. Eichelberger, J.C.; Koch, F.G. (Los Alamos Scientific Lab., NM). *J. Volcanol. Geotherm. Res.;* **5**: No. 1/2, 115-134(Feb 1979).

Lithic fragments are a highly varied but significant component of the Bandelier Tuff, Jemez Mountains, New Mexico. Lithic material occurs in concentrations from trace amounts to 30 wt %, and within the Otowi member of the tuff has a total volume of 10 km^3. Approximately 90% of the fragments are Cenozoic volcanic rocks of the Jemez volcanic field, 10% are Paleozoic sedimentary rocks, and only trace amounts are Precambrian basement. The large volume of lithic material and predominance of shallowly derived fragments requires substantial flaring of the vent near the surface. The cooling effect of $\geqq$ 10 wt% lithic fragments was sufficient to inhibit welding of the tuff. Many of the basement fragments appear to have been derived from a contact metamorphic zone surrounding the magma chamber. This zone is characterized by shearing and recrystallization, by development of veins of actinolite, augite, and epidote, and by alteration of hornblende to F-rich biotite. Water and fluorine involved in the alteration may have come from the magma chamber.

NON-USA

49802 (LBL—7001) Study of the structural control of fluid flow within the Cerro Prieto Geothermal Field, Baja California, Mexico. Noble, J.E.; Manon, M.A.; Lippmann, M.J.; Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977. Contract W-7405-ENG-48. 18p. (CONF-771014—4). P 02/MF A01.

From 52. annual meeting of the Society of Petroleum Engineers; Denver, CO, USA (9 Oct 1977).

The Lawrence Berkeley Laboratory and the Comision Federal de Electricidad of Mexico are conducting a joint investigation of the Cerro Prieto Geothermal Field, located approximately 35 km south of Mexicali, Baja California, Mexico, in the Sea of Cortez-Salton Trough. Recent analyses of various geophysical/electrical logs, temperature logs, production and geochemical data and the subsequently developed preliminary model of the structure of the

geothermal system and the distribution of geothermal fluids are presented. Techniques routinely applied to petroleum exploration were successfully used in the development of a preliminary model of this water-dominated system. The study indicates the upwelling of geothermal fluids along an east bounding fault from a deep, as yet unexplored source. The fluids dissipate into various sand horizons at various depths. The resulting stratigraphic and fluid flow model is of importance in planning additional developments of the Cerro Prieto Geothermal Field.

49803 Geological investigation of hydrothermal alteration haloes in Japanese geothermal fields. Part 1. Sumi, K.; Igarashi, T.; Takashima, I.; Kimbara, K.; Nishimura, S. (eds.). Kawasaki, Japan; Geological Survey of Japan (1978). 631p. (In Japanese). (NP—23708). Geological Literature Center, Tokyo, Japan.

This report contains 16 papers on hydrothermal alteration haloes in Japanese geothermal fields. Many maps, graphs, and photographs are provided. A separate abstract is provided for each paper.

49804 Targets and procedures of geological investigations of hydrothermal alteration haloes in Japanese geothermal fields. Sumi, K.; Igarashi, I.; Takashima, I.; Kimbara, K.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 1-6(1978). (In Japanese). (NP—23708).

The geological investigations on hydrothermal alteration haloes have been carried out since 1973 by the Geological Survey of Japan at geothermal fields throughout Japan with special interest in their distribution, mineralogical composition and radioactive age. The actual alteration haloes, however, are generally much larger than the bare land because plants grow to cover the alteration haloes soon after extinction of the superficial geothermal activity which caused the haloes. The time required for restoration of vegetation is undoubtedly shorter than that of the life of an underground heat reservoir. Thus, the alteration haloes covered by vegetation, are very important in prospecting buried geothermal resources. The most productive Matsukawa wells, MR6 and MR7, were drilled in the central alunite zone, where there had been no superficial thermal manifestations, covered by the dense forest. Further development in Matsukawa has been hampered by the steep topography, but the power potential is estimated to be 120 MW from the ratio of developed power capacity to the corresponding altered area, that is, 20 MW/0.35 km^2. Based on the ideas stated above preliminary studies were carried out at Tamagawa, Matsukawa and Kuju in 1974, and a procedure for an alteration survey was proposed. It is composed of eight parts as follows: (1) photogeologic observation, (2) distribution survey of the altered area, (3) stratigraphic survey of the altered area, (4) microfossil analysis, (5) radioactive age dating, (6) x-ray analysis, (7) chemical analysis, and (8) calculation of discharged heat. Investigations have been completed at 15 fields. Fourteen references are provided.

49805 Geological investigation of hydrothermal alteration haloes in Toyoha geothermal field, Hakkaido. Igarashi, T.; Furukawa, Y.; Sugawara, K.; Nishimura, S.; Okabe, K. *Chishitsu Chosajo Hokoku;* No. 259, 9-41(1978). (In Japanese). (NP—23708).

In Toyoha geothermal field, the altered haloes are located along a tectonic line extending on a NW-SE direction along the Yunosawa River, east of the Toyoha Mine, a well known Neogene epithermal ore deposit. The investigation was carried out to clarify the stage of alteration, based on the altered haloes geologic structure, composition, and size. The Quaternary distribution at the eastern foot of Mt. Yotei was also studied. The field is covered by various kinds of Miocene sediments but the altered haloes are found only in an area covered by the Takinosawa formation and its older formations. Among the Yunosawa, Koyanagizawa and Takinosawa alteration haloes, the Yunosawa is the most important. It is composed of blocky silicified rock extending along a river and surrounding argillaceous rock. The silicified rock is composed primarily of quartz and subordinate alunite and opal, while the argillaceous rock consists chiefly of kaloin and is characterized by the occasional presence of sericite and montmorillinite. Fission-track and ^{14}C methods were employed to determine the stage of alteration, but the results were unsatisfactory. The sublimation sulfur ore deposits in the Yunosawa and Koyanagizawa areas were comparatively small, but their original depositional features remain intact, indicating that geothermal activity continued until recently. Yunosawa is the most promising area as it is closely related to the tectonic line and also it has extraordinarily high ground temperature determined by a recent heat flow survey. Twenty-three references are provided.

49806 Geological investigation of hydrothermal alteration haloes in Kitayuzawa geothermal field, Usu-gun, Hokkaido. Yamaguchi, S.; Igarashi, T.; Chiba, Y.; Saito, S.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 43-83(1978). (In Japanese). (NP—23708).

In the Shikotsu-Toya district, many geothermal indicators exist such as the Toya-ko, Noboribetsu, and Kitayuzawa hot springs. Kitayuzawa was selected for investigation because its hot springs are relatively high in temperature. Its geothermal alteration, geologic age, nature and size, and relation to geologic structure have been studied. The geology is composed of the pre-Tertiary basement of granodiorite, green tuff of the Neogene Osarugawa Formation, pyroclastic rocks of the Neogene Kitayuzawa Formation and the Shoen Volcanic Breccia, the late Tertiary to Quaternary volcanic rocks, and the Quaternary terrace deposits and ejecta from the Toya, Shikotsu, and Usu volcanoes. There are four altered areas: one around Kitayuzawa, one along a stream below the Bankei hot springs, one alone the middle to upper region of the Tokushumbetsu River, and one down-stream of Hongo-zawa. The first three are large and have been subjected to considerable alteration. In general, the altered areas extend in a NNE to SSW direction and they are composed of a silicified zone with a surrounding argillized zone. Two alteration stages exist. The fission-track method dated the first stage as about 1.6 to 1.7 MyBP. Flowing hot springs and the presence of cinder piles, indicate that the second zone is more recent. From the results of investigations of geothermal phenomena, including stages of geothermal alteration, geologic structure, recent hot springs and fumaroles, it is concluded that the most promising area for geothermal exploitation is the one extending from the Kitayuzawa hot spring east to the mountainous area.

49807 Geological investigation of hydrothermal alteration haloes in Nigorikawa geothermal field, southwestern Hokkaido. Igarashi, T.; Sato, K.; Ide, T.; Nishimura, S.; Sumi, K. *Chishitsu Chosajo Hokoku;* No. 259, 85-180(1978). (In Japanese). (NP—23708).

The hydrothermal alteration haloes in Nigorikawa geothermal field, Hokkaido have been geologically investigated with special interests in their distribution, mineralogical compositions and radiometric ages. The geothermal field is situated within the late Pleistocene Nigorikawa caldera. There are 28 hot springs of 43 to 92°C and 7 fumaroles of 16 to 38°C. Geothermal activity in this area is related to the volcanism of the Nigorikawa caldera. Immediately before the subsidence of the caldera, the Ishikura pumice was deposited (a pyroclastic flow deposit). An alteration halo is found at a fumarolic area in the northwestern margin of the caldera. It is about 0.7 km^2 in area and classified into an inner siliceous part composed mainly of α-cristobalite, amorphous silica, and alunite, and an outer argillized part. Altered volcanic rocks of the 2100 x 10^3 year old Torisakigawa Formation is unconformably covered by the unaltered Bozuyama Formation of 11,340 years ago or the Ishikura Pumice Bed of 11,670 years ago. Limonite or travertine beds are intercalated in Holocene deposits. Therefore the main stage of hydrothermal alteration is older than about 11,000 years. Nineteen references are provided.

49808 Geological investigation of hydrothermal alteration haloes in Shikabe and Ofuna geothermal fields, southwestern Hokkaido. Igarashi, T.; Ishida, M.; Okabayshi, N.; Aoki, K.; Yamaguchi, S.; Niahimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 181-237(1978). (In Japanese). (NP—23708).

Surveys on the metasomatized area of Shikabe-mura were carried out in order to clarify its alteration age and tectonic situation in southern Komagatake District. Its geology and scale were also investigated. The geology is composed of late Cenozoic rocks; the Shiodomari Formation and the Togeshita Pyroclastic Rocks of Miocene to Pliocene in age and the early Quaternary Shikabe Formation. All of them scarcely show effects of mineralization or alteration and shearing stress. The shearing stress resulted in many shear zones composed of conjugated cracks in the direction of N20°W to 40°W and N20° to 40°E. The Neogene rocks were subjected to extensive alteration to produce silicified rocks and blue grayish or white argillite. The alteration affected the youngest rocks of Neogene, but is not observed in the Quaternary terrace deposits. A zonal arrangement was formed in an extensively altered area, in which a silicified zone is in the center, successively surrounded by montmorillonite-alunite, zeolite, and halloysite-feldspar zones. As for travertine, two types exist: one is characterized by the presence of limonite and the other by calcium-carbonate and sulfur. The former type is observed along the Shozin-gawa and the Amemasugawa and the latter one around the Shikabe-gawa, Isoya, and Ofuna hot springs in the area. Twenty-nine references are provided along with numerous maps and photographs.

49809 Geological investigation of hydrothermal alteration haloes in Sagayu geothermal field, Aomori Prefecture. Satoh, H.; Nakagawa, K.; Kuwahata, K.; Yamada, K.; Tokunga, S. *Chishitsu Chosajo Hokoku;* No. 259, 239-279(1978). (In Japanese). (NP—23708).

The hydrothermal alteration haloes in Sagayu geothermal field, Aomori Prefecture, were studied geologically with special interests in their distribution, mineralogical compositions and radiometric ages related to pollen analyses. Sagayu geothermal field is situated in the Hakkoda Group at the northern end of Honshu. It was formed after the eruption of the Hokkoda Welded Tuff about 2 million years ago. It has ten altered haloes and points and amounts to about 3.22 km^2 in total area. The original rocks of these alteration haloes are Miocene rhyolite, hard shale, and andesites and Pleistocene mudflow deposits. Therefore, the main alteration ceased about 16,000 years ago. Each halo is surrounded by an argillized zone. Many hot springs and vapors issue from the central cristobalite zone. Thirty-four references and numerous maps and tables are provided.

49810 Hydrothermal alteration of Onuma geothermal area, Akita Prefecture, northeast Japan. Takashima, I.; Fuchimoto, H.; Kubota, Y.; Hayashi, I.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 281-310(1978). (In Japanese). (NP—23708).

Distribution and size of the altered area were surveyed in order to estimate the geothermal potential. Mineral occurrence, distribution of travertine, fission track and ^{14}C datings, pollen and chemical analyses have been performed to determine sources. Twenty-two altered zones have been identified and amount to 5.37 km^2 in total area. Altered minerals which occurred in each zone are summarized in a table. ^{14}C and fission track datings showed that the altered zones were formed at two different ages. One is older than 1.6 My and the other is over 33,000 years BP to present. Sulfur and limonite beds were recognizable and their distributions are plotted. The shapes of the altered zones are elongated in E-W and N-S directions. The former is assigned to younger altered zones and the later older ones. Fifteen references and numerous tables and maps are provided.

49811 Geological study on hydrothermal rock-alteration in Kawarage geothermal field, Akita Prefecture, Japan. Taniguchi, M.; Okada, H.; Sumi, K. *Chishitsu Chosajo Hokoku;* No. 259, 311-339(1978). (In Japanese). (NP—23708).

Many hot springs were studied about 15 km northwest of the Kurikoma volcano. They are accompanied by active fumaroles in the surrounding altered areas, and are part of the largest geothermal area in Japan. The main altered areas are Akinomiya, Kawarage-Doroyu, Akayunomatazawa, Oyasu-Metaki, and Ooyu. Among them, the Kawarage altered area seems to be the center of geothermal activity. The silicified zone predominates and sublimated sulfur was once mined. The pH values of the hydrothermal solutions in Kawarage hot springs are remarkably low and range from 1 to 2. In Akinomiya, Oyasu-Metaki, and Ooyu altered areas surrounding the above-mentioned area, argillized zones are widely distributed, in which clay minerals (kaolin, montmorillonite, and sericite) and zeolite minerals (mordenite, stilbite, laumontite, and yugawaralite) are predominate. The pH values of their hydrothermal solutions are relatively high. Bedded limonitic iron ore is conspicuous in Horaitakamatsu, Yunomata, and Ootori (Katatsumuriyama) minor altered areas, where there are cold springs, in addition to the mentioned five main altered areas. Fifteen references and numerous maps and graphs are provided.

49812 Hydrothermal alterations of the Karayama and Narugo geothermal areas, Tamatsukuri-gun, Miyagi Prefecture. Yamada, E.; Okada, H.; Nishimura, S.; Taniguchi, M.; Natori, H. *Chishitsu Chosajo Hokoku;* No. 259, 341-374(1978). (In Japanese). (NP—23708).

In the Onikobe district, the white hydrothermally altered areas are 3.01 km^2 in area. The Katayama-Arayu zone has the largest area of about 2.34 km^2. Intensely altered rocks have been changed into homogeneous siliceous rocks rich in α-cristobalite and amorphous silica. Intensely argillized rocks contain kaolin and often alunite. The Akazawa alteration zone occupies an area of about 0.44 km^2. The northeastern part of it consists of α-cristobalite or amorphous silica rich silicified rocks and kaolin bearing argillized rocks, while heulandite or mordenite containing zeolitized rocks are distributed in the southwestern part. Three ^{14}C ages of carbonized woods are 24,970 +- 1,210 years BP, 23,380 +- 890 years BP, and older than 32,500 years BP. The tuffaceous volcanic conglomerate and sandstone beds are mostly mudflow origin and they contain white altered fragments of pebble- to cobble-size, while the strata themselves are only weakly altered. Therefore, the hydrothermal alteration in the eastern part of the Katayama-Arayu alteration zone took place probably before the above-mentioned ages. In the Narugo district, the white hydrothermally altered areas are 1.0 km^2 in area and are comprised of the Katanuma, the Motoyu, the Nakano, and Nakayamadaira, and the Kawabata alteration zones. Among them the first occupies the widest area of 0.48 km^2, where silicified rocks containing quartz, α-cristobalite, and often alunite are predominant. The others consist mainly of argillized rocks containing kaolin, montmorillonite and/or chlorite. Twenty-three references and numerous tables and maps are provided.

49813 Geological study on hydrothermal rock alteration in Hijiori geothermal area, Yamagata Prefecture, Japan. Taniguchi, M.; Makita, T.; Kawai, Y. *Chishitsu Chosajo Hokoku;* No. 259, 377-413(1978). (In Japanese). (NP—23708).

The hydrothermally altered area is distributed in Hijiori caldera which is situated in Ookura Village, Yamagata Prefecture, in which many hot springs are produced including the Hijiori and Kanayama hot springs. The Quaternary sediments and the hydrothermal alteration in the caldera and its vicinity were studied. The Hijiori caldera deposits (95 m+) are composed of dacitic tuff, lapilli tuff, tuff breccia, muddy sediments and conglomerates. The argillized zones which are distributed along the Tetsuzangawa stream (in Akazunayama district) and the Nagakuragawa River (near the Imagami hot spring), are very small. No hydrothermal mineral indicating geothermal activity was found. The Hijiori caldera deposits were subjected to hydrothermal alteration by geothermal activity in the southern part of the caldera, in which the altered area is divided into the following two sub-areas: the Hijiori sub-area covers an area of about 0.36 km^2 around the Kozangawa River, in which the argillized zone encloses the silicified zone. Montmorillonite, sericite, chlorite, pyrite, α-cristobalite and quartz are found. The Kanayama sub-area covers an area of about 0.81 km^2 around the Irawajisawa stream and the Nigamizugawa River, in which the argillized zones and the silicified zones are repeatedly stratified parallel to the bedding plane. Montmorillonite, kaolin, sericite, alunite, pyrite, α-cristobalite and quartz are found. Iron sulfide and limonitic ore mineral are bedded in the dacitic sediments as sinter deposits in Kanayama sub-area. Fifteen references are numerous tables and maps are provided.

49814 Geothermal rock alteration at Ubayu Hot Springs and its vicinity, Yamagata Prefecture, Japan. Togashi, Y.; Kubota, Y.; Yamda, E.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 415-435(1978). (In Japanese). (NP—23708).

White geothermal alteration areas composed of silicified and argillized zones, were estimated to occupy an area of about 11 km^2 in northern Azuma district, Yamagata Prefecture. The alteration areas, whose original rocks are composed of pre-Quaternary rocks, are thought to have partly resulted from pre-Quaternary argillizations, which have no significant relationship to the Quaternary geothermal activity. A geothermal alteration area is now being formed around Ubayu Hot Springs. Its thermal water shows strong acidity (pH = 2.3 to 2.4) and contains much more metal cations and H_2S than any other hot springs in the surveyed district. The geology of the Ubayu geothermal area is composed of Miocene acid welded tuffs (Itaya Formation) and its overlying Quaternary andesitic rocks (Azuma Volcanic Rocks). The latter shows the fission track age of 0.34 million years. These rocks are intensely silicified and argillized. The silicified zone has a dike-like shape of 20 to 40 m in width and extends in a NWW-SEE or NNW-SSE direction. No silica mineral other than quartz was found in the altered rocks from the Ubayu geothermal area by means of x-ray diffraction, and pyrophyllite (monoclinic) was the most abundant clay mineral in and around the area. The results of the heat discharge survey for northern Azuma district indicated that Shirabu-Takayu Hot Springs (pH = 6.8 to 7.2), which is situated at the westernmost point of the surveyed district, discharges about 56% of the total heat discharge of the surveyed area, and the Ubayu area is the second (32% of the total). Seventeen references and numerous maps and tables are provided.

49815 Quaternary stratigraphy and hydrothermal alteration of Noji geothermal area, Fukushima Prefecture, Japan. Togashi, Y.; Sato, K.; Takanohashi, M.; Chiba, Y.; Nishimura, S.; Suzuki, K. *Chishitsu Chosajo Hokoku;* No. 259, 437-465(1978). (In Japanese). (NP—23708).

The results of the alteration zone survey for southern Azuma District, Fukushima Prefecture, performed in 1974 are presented. The alteration zone survey included the Quaternary stratigraphy; distribution of the white alteration zones (silicified and argillized zones); and determination of the period of geothermal activity by means of fission-track and ^{14}C age determination methods. The surveyed area is composed of the Arakawa River area, southeast of Fukushima City, and the Sukawa River area, east of the city. The Quaternary stratigraphy includes andesitic pyroclastic rocks and mud flow deposits, inferred to be of Plio-Pleistocene age, and andesitic lavas, estimated to have erupted 0.81 to 0.82 million years ago. No evidence of later volcanic activity is found at the Arakawa River area, while andesitic lavas and pyroclastics deposited during Late Pleistocene (about 26,000 to 23,000 years ago, by means of the ^{14}C method) at the Sukawa River area. The white alteration zone is estimated to cover an area of 11.6 km^2 in the surveyed area and is composed of quartz, α-cristobalite and α-tridymite, surrounded by the argillized zone composed mainly of alunite, kaolinite and montmorillonite. Formation of the alteration zones, including the present geothermal activity is considered to have occurred five times at least from the relation between the hydrothermal alteration and the stratigraphy. Geothermal activity indicators include Noji, Washikura, Makukawa, Hatohana, and Takayu Hot Springs. Some test drilling for power production has been performed at Jigokundani Valley near Noji Hot Spring. Eleven references and numerous tables and maps are provided.

49816 Zonal arrangement of hydrothermal rock alteration of Kasatsu-Shirane Hanashiki geothermal area, Gumma Prefecture. Ueno, M.; Mado, H.; Kimbara, K.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 467-515(1978). (In Japanese). (NP—23708).

Hydrothermally altered rocks resulting from geothermal action are widely distributed in the volcanic rock area around Mts. Motoshirane and Shirane. The hydrothermally altered rocks are classified into the following four types: a type related to sulfur and iron sulfide ore deposits of impregnation and replacement types; a type along tectonic or fault lines; a type in old craters or around active craters; and a type accompanied by hot springs. Mineralogical replacement in the first, second, and third types consists mainly of argillization (kaolinite, halloysite) and silicification (quartz, α-cristobalite, tridymite). Each type is occasionally accompanied by aluniti-

zation, opalization, and pyritization. Distribution of the hydrothermally altered rocks is presumably related to lithologically weak zones. Accordingly, active solfataric and fumarolic zones near the craters should be selected as sites for geothermal exploration. Twenty-three references, numerous maps, and tables are provided.

49817 Hydrothermal alteration of Kawazu-Shimogamo geothermal area, Shizuoka Prefecture, Central Japan. Takashima, I.; Motegi, M.; Nishimura, S. *Chishitsu Chosajo Hokoku;* No. 259, 517-536(1978). (In Japanese). (NP—23708).

Distribution and size of the altered area have been surveyed in order to estimate geothermal potential. Its mineral occurrence, distribution of travertine, fission-track and ^{14}C dating, pollen and chemical analyses have been performed. Twenty-six altered zones amounting to 3.47 km^2 in total area have been identified. The altered minerals which occurred in each zone are summarized. Pyrophyllite and diaspore indicating high temperature are found only in Kawazu K zone. The altered zones are mostly related to the Tertiary rhyolite and dacite intrusions. The zones seem to have nothing to do with the present-day thermal manifestations. The hot springs are mostly situated at the intersections of NE-SW and E-W topographic lines. Thirteen references and numerous maps and tables are provided.

49818 Geological investigation of hydrothermal alteration haloes in Ibusuki geothermal field, Kagoshima Prefecture. Kamitani, M.; Nakagawa, S.; Nishimura, S.; Sumi, K. *Chishitsu Chosajo Hokoku;* No. 259, 537-577(1978). (In Japanese). (NP—23708).

The hydrothermal alteration haloes in Ibusuki geothermal field, Kagoshima Prefecture, have been studied geologically with special interest in their distribution, mineralogical compositions, and radiometric ages. The Ibusuki geothermal field is situated within the Ata caldera at the southern end of Kyushu. It was formed immediately after the eruption of Ata pumice flow 24,500 years ago. The caldera is about 13 km in diameter and filled by post-caldera volcanic rocks intercalcated with lake deposits. A row of younger calderas or craters (Ikeda, Ikesoko, Unagi, Narikawa, and Yamakawa) runs in a northwest-southeast direction crossing Ata caldera. Ikeda caldera, one of the younger calderas, erupted Ikeda pumice flow immediately before its depression 4640 years ago. There are five altered haloes: Gongen-Minamisakoda, Matsugakubo-Ikesoko, Unagi, Washiodake, and Fushime. Their total area is about 6.1 km^2. The original rocks of these alteration haloes are caldera-filling rocks, whose radiometric ages are 25,000 and 27,000 years BP. Therefore, the formation of the haloes is younger than 25,000 years. Each halo is divided into a inner silicified zone characterized by the presence of α-cristobalite, kaolin, and alunite, and an outer argillized zone characterized by kaolin and montmorillonite. Matsugakubo-Ikesoko and Washiodake altered haloes, which have no exhalations, are covered by unaltered lake deposits of 8280 years ago. Gongen-Minamisakoda, Unagi, and Fushime haloes, which have exhalations, are covered by unaltered Ikeda pumice flow deposits of 4640 years ago. Ikeda pumice flow deposits and Kaimon ash, however, are sporadically altered to some extent. Seventeen references and numerous maps and tables are provided.

49819 Pollen analysis in geothermal fields in Japan (Part 1). Onoue, T.; Tokunaga, S.; Oshima, H.; Ito, Y. *Chishitsu Chosajo Hokoku;* No. 259, 579-623(1978). (In Japanese). (NP—23708).

The results of pollen analyses of samples from geothermal fields throughout Japan are presented. Eighty samples from 18 localities were analyzed. These samples ranged in age mostly from the Pleistocene to Holocene and the pollen assemblages showed a regional difference. The conifers of around 30,000 years ago, such as Larix, Abies and Picea indicating a cool or cold climate, are found in Hokkaido. Abies and Pinus of the same age are found predominantly in mountain areas of the Tohoku district Honshu. Cryptomeria, Fagus, and Salix of 15,000 and 30,000 years ago are found in southern areas in Honshu. The palynological division in this study corresponds to the standard division after the ice age, established by J. Nakamura and M. Tsukada. But there are a little difference in pollen diagrams in Kyushu. These results of pollen analyses are available for the establishment of the Quaternary stratigraphy in the geothermal fields as well.

49820 Results of electric prospecting of geology, hot springs, and ground water in and around the Yuzawa City highway, Akita Prefecture. Kondo, G. (Akita University, Japan). *Akita Geology (Akita Chigaku);* No. 26, 1-9(1977). (In Japanese).

The geological stratigraphy of the Yuzawa City highway is based on the Kitayuzawa andesitic rocks of the Neogene system. The formation between the Yuzawa volcanic conglomerate and the Yamaya mudstone formation was named the Yamaya group. The volcanic rocks of Ontakesan and Yunokamisan were formed by eruptions. Boring tests showed that the temperature of Yunohara hot springs remains between 28 and 30°C. It flows out of the Kitayuzawa andesitic rocks, and the quality of the water is similar to that of seawater. There appears to be a heat source elsewhere in this area which is closely related to the volcanic activity of the Neogene system.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 49802, 49804

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 49807, 49809

49821 (LA—7761-MS) **Capacitive discharge firing system for providing acoustic sources in the hot dry rock geothermal energy development project.** Patterson, W.W.; Deam, D.R.; MacDonald, H.J.; Rochester, R.H. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 15p. P 02/MF A01.

The development of a capacitive discharge firing unit designed to initiate electrically exploded foil slapper detonators in a subsurface, high-pressure (5000 psi), high-temperature (> 200°C) environment is described. The unit is used to conduct acoustic ranging experiments in deep boreholes (≅ 10,000 ft) in the Los Alamos Scientific Laboratory Geothermal Hot Dry Rock experiment.

49822 (NP—23867) **Exploration of the Tongonan geothermal field, Leyte, Philippines.** (Kingston, Reynolds, Thom and Allardice Ltd., Auckland (New Zealand)). Feb 1979. 21p. U 02/MF A01.

Geological, geochemical, and geophysical techniques have been used successfully in the exploration and identification of a commercial geothermal resource at Tongonan on the island of Leyte in the Philippine archipelago. Subsequent exploration and delineation carried out over a period of two years have proved a reserve equivalent to 3,000 MWe years of electrical energy; a power plant of 112 MWe capacity is currently under development. Results of further step-out exploration drilling indicate potential exists for expanding proven reserves two- or three-fold. The position of exploration in the development of a geothermal power plant is shown.

49823 New data on heat flow crossing the bottom of Caspian Sea. Aliev, S.A.; Ashirov, T.; Lipsits, Yu.M.; Sopiev, V.A.; Sudakov, N.P. (Inst. of Seismology, Ashkhabad, USSR). *Izv. Akad. Nauk Turkm. SSR, Ser. Fiz.-Tekh., Khim. Geol. Nauk;* No. 2, 124-126(1979). (In Russian).

Geothermal investigations at sea have been carried out in the USSR for the aquatic areas of the northern and middle portion of Caspian Sea. The magnitude of heat flow varies from 0.44 to $2.55.10^{-6}$ kcal/sm^2.sec. The differentiation of heat flow fields within the various geotectonical structures has been shown.

GEOCHEMICAL TECHNIQUES AND SURVEYS

49824 Evidence from fluid inclusions for a paleogeothermal gradient at the geothermal test well sites, Los Alamos, New Mexico. Burruss, R.C.; Hollister, L.S. (Princeton Univ., NJ). *J. Volcanol. Geotherm. Res.;* 5: No. 1/2, 163-177(Feb 1979).

Homogenization temperatures of individual fluid inclusions from the geothermal test well sites near Los Alamos, New Mexico, systematically change as a function of depth in the cores. Inclusions in samples from depths between 1.5 and 3.0 km have re-equilibrated to thermal gradients higher than the present gradient of 50 to 60°C/km. The loci of maximum temperatures attained has a slope of about 70°C/km; the deepest samples has cooled to 200°C from a maximum of 230°C. The wide range of salinities (0.0 wt% equivalent NaCl to more than 25 wt% equivalent NaCl) observed in each sample indicates a large amount of pervasive fluid circulation had not occurred at the time of re-equilibration of these inclusions. The results are relevant to calculations for the thermal history of the test site.

EXPLORATORY DRILLING AND WELL LOGGING

49825 (LA—7889-MS) **Case history report on East Mesa and Cerro Prieto geothermal fields.** Davis, DG.; Sanyal, S.K. (Los Alamos Scientific Lab., NM (USA); Scientific Software Corp., Denver, CO (USA)). Jun 1979. Contract W-7405-ENG-36. 183p. P 09/MF A01.

Well log analysis as applied to the geothermal industry is one of the areas of technology in great need of further development. One means of improving log analysis technology is to study case histories of the past uses of log analysis as applied to specific fields. The project described in this report involved case history studies on two well-known geothermal areas in North America: the East Mesa field in California and the Cerro Prieto field in Mexico. Since there was considerably more pertinent material available on East Mesa, a major part of the effort on this project was devoted to studying the East Mesa field. One particular problem that first came to attention when studying the Cerro Prieto data was the difficulty in determining actual formation temperature at the time of logging. Since the

temperature can have a significant effect on well log readings, an accurate temperature determination was considered to be important.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

49826 (LBL—8615) **Environmental and economic effects of subsidence: Category 4, Project 1. Final report.** (EDAW, Inc., San Francisco, CA (USA); Earth Sciences Associates, Palo Alto, CA (USA)). May 1979. Contract W-7405-ENG-48. 242p. P 11/MF A01.

A list of more than 70 subsidence areas was screened to select those areas which seemed to have the best potential for providing reliable data. The screening process is described in an appendix. Nine areas were selected for detailed case studies to collect all available data on the environmental and economic effects of the subsidence. Available information from the subsidence areas not selected as case studies was tabulated for each area and is included in an appendix. The nine case study areas are: Arizona; San Joaquin Valley, California; Baldwin Hills, California; Santa Clara Valley, California; Wilmington, California; Las Vegas Valley, Nevada; Houston-Galveston area, Texas; Mexico City, Mexico; and Wairakei, New Zealand. (MHR)

49827 (UCRL—52684) **Northern California Power Association—Shell Oil Company Geothermal Project No. 2: energy and materials resources.** Hall, C.H.; Ricker, Y.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1979. Contract W-7405-ENG-48. 12p. P 02/MF A01.

The potential environmental impact of the energy and material resources expended in site preparation, construction, operation, maintenance, and abandonment of all phases of the Northern California Power Association—Shell Geothermal Project in The Geysers—Calistoga Known Geothermal Resource Area is described. The impact of well field development, operation, and abandonment is insignificant, with the possible exception of geothermal resource depletion due to steam withdrawal from supply wells during operation. The amount of resource renewal that may be possible through reinjection is unknown because of uncertainties in the exact amount of heat available in the steam supply field. Material resources to be used in construction, operation, and abandonment of the power plant and transmission lines are described. Proposed measures to mitigate the environmental impacts from the use of these resources are included. Electric power supply and demand forecasts to the year 2005 are described for the area served by the NCPA.

GEOTHERMAL POWER PLANTS

POWER PLANT SYSTEMS AND COMPONENTS

REFER ALSO TO CITATION(S) 49663

49828 (TREE—1365) **Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource.** Demuth, O.J. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-07-1570. 105p. P 06/MF A01.

Analyses of a number of geothermal binary-cycles were made with the objective of finding a cycle which can produce low-cost electrical energy from a moderately low-temperature geothermal resource. Cycles were screened which included isobutane, pentane, cis-2-butene, and several mixed-hydrocarbon working fluids. Dual- and triple-boiling cycles were analyzed. Both shell-and-tube and direct-contact boilers, heaters, and condensers were assessed. A geothermal fluid (geo-fluid), typical of Raft River resource conditions was assumed, which has a temperature of 290°F and 52 parts per million dissolved nitrogen. Special emphasis in the analyses was directed toward investigation of several methods for keeping the loss of working fluid for the cycle at an acceptable level. It was concluded that for the Raft River geo-fluid, the direct-contact cycle has a potential for net geofluid utilization effectiveness values, (watt-hr/lbm geo-fluid) equivalent to those of the shell-and-tube cycle. Therefore, because of the lower cost of direct-contact components, a potential exists for the direct-contact plant to produce lower cost electrical energy than a comparable shell-and-tube plant. Advanced cycles were assessed which showed improvements in net geo-fluid utilization effectivness, relative to the first Raft River 5-MW Pilot Plant (dual-boiling, shell-and-tube isobutane cycle), of up to 19%.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

49829 (BNL—51024) **Development of cement for geothermal wells. Final report.** Kalousek, G.L. (Brookhaven National Lab., Upton, NY (USA)). 1 Mar 1979. Contract EY-76-C-02-0016. 25p. P 02/MF A01.

Modifications of portland cement—silica and βC_2S—silica cements were studied at 150 to 350°C (302 to 662°F) and saturated steam pressure. Emphasis was on relating the chemistry of the cements to their properties. Particular attention was given to long-term strength, bond strength, and effects of weight-reducing agents. The effects of Al_2O_3, Fe_2O_3, SO_3, Na_2CO_3, and Na_2SO_4 on different binders were studied and were found to range from deleterious to beneficial. Aluminous tobermorite (A-Tobermorite), xonotlite, and truscottite were dominant ultimate binders. The present results and others indicate that truscottite may undergo serious strength retrogression upon long-term exposure. A-Tobermorite was stable to 250°C (472°F) or higher. Xonotlite exhibited a wide range in strength, and some limited evidence suggests that it too may undergo strength retrogression. No insurmountable difficulties were encountered with normal-weight cements, but light-weight cements posed some questions. With the problems at their current stage of definition, further research should be rewarding.

49830 (NP—23829) **Mahiao 1 drilling report: geothermal exploration project, Tongonan Leyte Philippines.** (Kingston, Reynolds, Thom and Allardice Ltd., Auckland (New Zealand); PNOC Energy Development Corp., Metro Manila (Philippines)). Aug 1978. 32p. U 03/MF A01.

Drilling of M1 was completed at 1946.8 m RKB total depth on 11 January 1977, a total of 82 days. M1 is the first of twenty projected geothermal exploration and development wells to be drilled. The drilling of the well and the initial completion tests performed prior to releasing the rig are covered. (MHR)

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

49831 (LBL—9056) **Numerical model of transient two phase flow in a geothermal well.** Miller, C.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 4p. (CONF-790906—6). P 02/MF A01.

From Geothermal Resources Council annual meeting; Reno, NV, USA (24 Sep 1979).

The one-dimensional transient two phase flow in a geothermal well has been modeled with a finite difference approximation. The equations of mass, momentum and energy are solved using a partially implicit method. Terms that would place a severe time restriction on the calculation are solved implicitly while other terms are solved explicitly for computational ease and efficiency. The wellbore model includes heat and mass transfer and is coupled to a simple reservoir model. It is used to investigate the transient behavior in a single or two phase well during well testing. Results show that when the reservoir has a relatively large value of kh, as exists in a geothermal field, the slope of the log (pressure) vs. log (time) curve is not necessarily a unit slope. The early time behavior of this curve is controlled by the interaction of the flow in the reservoir and that in the well, and can be used to determine near bore values of kh. Heat loss in the wellbore is shown to also affect the pressure vs. time plot.

49832 (LBL—9326) **Status of geothermal reservoir engineering research projects supported by USDOE/Division of Geothermal Energy.** Howard, J.H.; Schwarz, W.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 5p. (CONF-790906—5). P 02/MF A01.

From Geothermal Resources Council annual meeting; Reno, NV, USA (24 Sep 1979).

In the fall of 1977, the US Department of Energy (DOE), Division of Geothermal Energy (DGE) proposed that Lawrence Berkeley Laboratory (LBL) assume lead responsibility, on DGE's behalf, for geothermal reservoir engineering. This summary discusses briefly the DOE/DGE-sponsored geothermal reservoir engineering research program which includes LBL in-house research and research done by others through LBL. LBL in-house research has emphasized improvement of well test analysis methods and the development of geothermal reservoir performance simulators. Work by others has included 18 separate contracts on a variety of technical and scientific projects. Altogether, 29 distinguishable research topics have been addressed. Fourteen institutions, including eight private companies, have interacted with the program. Table 1, along with figures 2 and 3 summarized the status of the work.

DIRECT ENERGY UTILIZATION

49833 (DOE/ET/28442—1) **Mountain Home Geothermal Project: geothermal energy applications in an integrated livestock meat and feed production facility at Mountain Home, Idaho.** Longyear, A.B.; Brink, W.R.; Fisher, L.A.; Matherson, R.H.; Neilson, J.A.; Sanyal, S.K. (Energetics Marketing and Management Associates Ltd., San Francisco, CA (USA); Longyear (Fred) Co., Sacramento, CA (USA); Agricultural Growth Industries, Inc., Concord, CA (USA);

International Engineering Co., Inc., San Francisco, CA (USA); Ecoview, Napa, CA (USA); Coopers and Lybrand, San Francisco, CA (USA)). Feb 1979. Contract ET-78-C-07-1704. 185p. P 09/MF A01.

The Mountain Home Geothermal Project is an engineering and economic study of a vertically integrated livestock meat and feed production facility utilizing direct geothermal energy from the KGRA (Known Geothermal Resource Area) southeast of Mountain Home, Idaho. A system of feed production, swine raising, slaughter, potato processing and waste management was selected for study based upon market trends, regional practices, available technology, use of commercial hardware, resource characteristics, thermal cascade and mass flow considerations, and input from the Advisory Board. The complex covers 160 acres; utilizes 115 million Btu per hour (34 megawatts-thermal) of geothermal heat between 300°F and 70°F; has an installed capital of $35.5 million;produces 150,000 hogs per year, 28 million lbs. of processed potatoes per year, and on the order of 1000 continuous horsepower from methane. The total effluent is 200 gallons per minute (gpm) of irrigation water and 7300 tons per year of saleable high grade fertilizer. The entire facility utilizes 1000 gpm of 350°F geothermal water. The economic analysis indicates that the complex should have a payout of owner-invested capital of just over three years. Total debt at 11% per year interest would be paid out in 12 (twelve) years.

49834 (SAN—1329-4) **Direct use applications of geothermal resources at Desert Hot Springs, California. Final report, May 23, 1977—July 31, 1978. Volume II: appendixes.** Christiansen, C.C. (Desert Hot Springs, City of, CA (USA)). Jul 1978. Contract EG-77-C-03-1329. 333p. P 15/MF A01.

The following appendixes are included: Desert Hot Springs (DHS) Geothermal Project Advisory Board, Geothermal Citizens Advisory Committee, community needs assessment, geothermal resource characterization, a detailed discussion of the geothermal applications considered for DHS, space/water heating, agricultural operations, detailed analysis of a geothermal aquaculture facility, detailed discussion of proposed energy cascading systems for DHS, regulatory requirements, environmental impact assessment, resource management plan, and geothermal resources property rights and powers of cities to regulate indigenous geothermal resources and to finance construction of facilities for utilization of such resources. (MHR)

GEOTHERMAL DATA AND THEORY

PROPERTIES OF AQUEOUS SOLUTIONS

49835 (LBL—9086) **Thermal conductivity of aqueous NaCl solutions from 20°C to 330°C.** Ozbek, H.; Phillips, S.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 26p. P 03/MF A01.

An evaluation of published data on the thermal conductivity of aqueous NaCl solutions is presented. The literature was screened from 1929 through 1979, and the evaluated data were tabulated. The data were converted where necessary to a set of internally consistent units of °C, watts/m-°C and molal concentrations. An empirical correlation equation with an average deviation of +-2% is given for the thermal conductivity of aqueous NaCl solutions from 20°C to 330°C at saturation pressures. A table of smoothed values generated using this correlation equation is provided for NaCl concentrations between 0 and 5 molal over this temperature range.

PROPERTIES OF MINERALS AND ROCKS

49836 **Studies of geothermal hot springs altered zone in Shizuoka Prefecture.** Takashima, I. (Geological Survey of Japan, Kawasaki). *Chishitsu Chosasho Nenpo;* No. 51, 60(1977). (In Japanese). (NP—23686).

In order to make age determinations on altered zones, an experimental thermo-luminescence device was manufactured. The device will be used to study the manner in which different ore species and temperature-increase rates affect the emission characteristics of luminescence. The species currently under study include quartz, feldspar, calcite, kaolinite, and zeolites. Heating rates of 40 to 80°C/min are being used. In the Takenoyu geothermal field in Kumamoto Prefecture, supplementary sampling was conducted to determine the distribution of quartz, cristobalite, and tridymite in the high-temperature portions of the altered zone.

TIDAL POWER

49837 **Tidal current energy - the predictable alternative power source.** *Electr. Rev. (London);* **204**: No. 12, 16-17(23 Mar 1979).

The potential for the utilization of tidal power in the United Kingdom is outlined. The most likely power plant designs are mentioned and some possible drawbacks are also briefly discussed.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 49601

49838 **Prospecting for meteorological energy in Hawaii.** Ramage, C.S. (Department of Meteorology, University of Hawaii, Honolulu, Hawaii 96822). *Bull. Am. Meteorol. Soc.;* **60**: No. 5, 430-438(May 1979).

Hawaii, with no indigenous fossil fuel resources, is particularly susceptible to oil shortages; hence, surveys have been underway for some time to evaluate the potential of wind and insolation as alternate energy sources. Since numerical modeling of the wind field is inadequate, we have been using fixed and mobile stations to monitor the wind distribution, finding that on parts of each of the main islands average speeds are more than adequate for economic power generation. A radiometer network on Oahu and scattered measurements elsewhere reveal that over most areas sheltered from the trade winds, insolation is as high as anywhere in the continental United States. We are using cloudiness data from weather satellites to refine the insolation maps. On recent field programs, we measured wind, insolation, temperature, humidity, and rainfall, aiming at improving our understanding of physical processes and at developing methods of wind and insolation forecasting.

49839 **Run duration analysis of surface wind speeds for wind energy application.** Sigl, A.B.; Corotis, R.B.; Won, D.J. (Department of Civil Engineering, South Dakota State University, Brookings 57006). *J. Appl. Meteorol.;* **18**: No. 2, 156-166(Feb 1979).

Hourly wind speed records are used to develop a model for the probability distribution of wind speed persistence above and below fixed reference speeds. Examination of duration histograms from 19 sites for records varying from 5—24 years lead to the development of a simple composite distribution. Enforcement of smooth behavior and a parameter sensitivity analysis allow the model to be interpreted in terms of a single free parameter, which is then shown to be highly correlated to the seasonal mean wind speed at a site.Comparison of run duration results for 1 and 3 h data (the latter being the standard digitization presently used by the National Climatic Center) indicates a definite bias with the 3 h records. A correction scheme is derived to improve the 3 h results.

ECONOMICS

REFER ALSO TO CITATION(S) 49759

49840 (EPRI-ER—978(Vol.2)) **Requirements assessment of wind power plants in electric utility systems. Final report.** Marsh, W.D. (General Electric Co., Schenectady, NY (USA). Electric Utility Systems Engineering Dept.). Jan 1979. 339p. P 15/MF A01.

A rational aproach is presented to the consideration of wind power plants applied to electric utility systems. A requirements assessment and preliminary impact and penetration analyses by studying wind generation in three actual utility systems are included. Conventional utility loss-of-load probability and production simulation methods were used, together with a wind turbine generator (WTG) performance model developed for the study. Evaluations were based on comparison of total utility generation system costs with and without wind plants, and were expressed in terms of wind power plant value and cost. Value is measured by the value of displaced energy and capacity of conventional power plants. Cost consists of the capital, and operating and maintenance costs of the wind plant.

49841 (EPRI-ER—978(Vol.3)) **Requirements assessment of wind power plants in electric utility systems. Volume 3. Appendixes. Final report.** Marsh, W.D. (General Electric Co., Schenectady, NY (USA). Electric Utility Systems Engineering Dept.). Jan 1979. 95p. P 05/MF A01.

This study first developed a rational approach to the consideration of wind power plants applied to electric utility systems, then performed a requirements assessment and preliminary impact and penetration analyses by studying wind generation in three actual utility systems. Conventional utility loss-of-load probability and production simulation methods were used together with a wind turbine generator (WTG) performance model developed for the study. Evaluations were based on comparison of total utility generation

system costs with and without wind plants, and were expressed in terms of wind power plant value and cost. Value is measured by the value of displaced energy and capacity of conventional power plants. Cost consists of the capital, and operating and maintenance costs of the wind plant.

49842 (LUTMDN/TMVK—3073/1-25(1978)) **Large-scale introduction of wind power stations in the Swedish grid: a simulation study.** Larsson, L. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Kraftteknik). Aug 1978. 27p. U 03/MF A01.

This report describes a simulation study on the factors to be considered if wind power were to be introduced to the south Swedish power grid on a large scale. The simulations are based upon a heuristic power generation planning model, developed for the purpose. The heuristic technique reflects the actual running strategies of a big power company with suitable accuracy. All simulations refer to certain typical days in 1976 to which all wind data and system characteristics are related. The installed amount of wind power will not be subject to optimization. All differences between planned and real wind power generation is equalized by regulation of the hydro power. The simulations made differ according to how the installed amount of wind power is handled in the power generation planning. The simulations indicate that the power system examined could well bear an introduction of wind power up to a level of 20% of the total power installed. This result is of course valid only for the days examined and does not necessarily apply to the present day structure of the system.

49843 (SERI/TR—35-225) **Summary of currently used wind turbine performance prediction computer codes.** Perkins, F. (Solar Energy Research Inst., Golden, CO (USA)). May 1979. Contract EG-77-C-01-4042. 29p. P 03/MF A01.

Informaion on currently used wind turbine aerodynamic/economic performance prediction codes is compiled and presented. Areas of interest to wind energy researchers that are not included in the reported codes are identified. Areas which are weak in experimental support are also identified.

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 49707

TURBINE DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 49843

49844 (DOE/NASA/1004—79/16) **Use of wind data with an operational wind turbine in a research and development environment.** Neustadter, H.E. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EX-76-A-29-1004. 14p. (NASA-TM—73832; CONF-790665—1). P 02/MF A01.

From American Meterological Society; Portland, OR, USA (19 Jun 1979).

The need to measure and collect wind data persists well after a wind turbine is initially made operational. This is particularly the case in an R and D program such as the Wind Energy Project being conducted by Lewis Research Center for the Department of Energy. The status is presented of the use of wind information in four areas, namely: Operational Control, Design Verification, Power Performance Analysis, and Lifetime Estimation. Attention is also given to some of the identified, but as yet unmet, wind informational needs and the steps planned to meet these needs.

49845 (DOE/NASA/1028—79/24) **Design, fabrication, and initial test of a fixture for reducing the natural frequency of the Mod-0 wind turbine tower.** Winemiller, J.R.; Sullivan, T.L.; Sizemore, R.L.; Yee, S.T. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jul 1979. Contract EX-76-A-29-1028. 21p. (NASA-TM—79200). P 02/MF A01.

Operation of the Mod-0 wind turbine with a tower first bending frequency less than twice the rotor speed was desired. This would provide an opportunity to study system dynamics for a soft tower as well as provide data for the system passing through resonance. The method selected to reduce the frequency was to place the original Mod-0 tower on a set of springs. The fixture fabricated to do this was designed so that the spring stiffness could be varied in the field to provide a range of tower frequencies. Design requirements and fixture fabrication details are given. Actual operation of the Mod-0 with the softening fixture showed that the desired tower natural frequencies were obtained. Only moderate fixture deflections were observed when the system passed through resonance.

49846 (DOE/NASA/20305—79/3) **Safety considerations in the design and operation of large wind turbines.** Reilly, D.H. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jun 1979. Contract AI01-79ET20305. 39p. (NASA-TM—79193). P 03/MF A01.

The Department of Energy, the NASA Lewis Research Center, and the Boeing Engineering and Construction Company are engaged jointly in the development of a 2500 kW wind turbine system (WTS) designated as the MOD-2 WTS. The goal of the MOD-2 project is to produce a wind powered electrical generating system for utility applications which will be economically competitive with conventional power generating equipment. The program started in August of 1977 and the first unit will be installed and operating by mid-1980. The MOD-2 is representative of large wind turbines and as such will be used to describe "typical" configurations. The process used to assure safety in the design and operation of the MOD-2 wind turbine is described.

POWER CONVERSION SYSTEMS

49847 (DFE—18) **Evaluation of the work within the field of wind energy.** Moberg, E. (Delegationen foer Energiforskning, Stockholm (Sweden)). Mar 1979. 111p. (In Swedish). U 06/MF A01.

A careful analysis of the work going on during 1975 to 1978 within the field concerning the introduction of wind energy in Sweden is made. Suggestions for the planning and performance of future work in this field are also given.

49848 (LUTMDN/TMVK—3069/1-9(1978)) **Discussion of different problems in connection with the choice of momentum exchange device at wind power plants.** Eriksson, B.; Helgesen, H. (Tekniska Hoegskolan, Lund (Sweden). Inst. foer Vaerme- och Kraftteknik). Aug 1978. 11p. (In Swedish). U 02/MF A01.

The aim of the investigation is to discuss different problems which occur in connection with the choice of change-over device between the rotor and the generator at a wind power plant.

SITE CHARACTERISTICS

REFER ALSO TO CITATION(S) 49844

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 50219

49849 (EPRI-EL—1102) **Effect of operating considerations on reliability indices used for generation planning. Final report.** Patton, A.D.; Hogg, G.L. (Texas A and M Univ., College Station (USA)). Jun 1979. 89p. P 05/MF A01.

Interest presently exists in examining the effects of system operating policies and constraints such as unit start-up times and start-up failures and flexibility to postpone outages on reliability indices used for generation planning. This interest stems from a desire to compute reliability indices that agree closely with actual system reliability performance and to evaluate the effect of different system operating constraints on reliability. A detailed Monte Carlo simulation computer program has been developed that is capable of incorporating the effects of many operating constraints on system reliability. This computer program represents a first step beyond the prototype, but not yet production grade, in the modeling of operating constraints. The present program was used to model 513 generating units and create an hour-by-hour artificial history of system capacity available and load. The program was developed in FORTRAN language and run on AMDAHL (compatible with IBM computers). It was used to study a synthetic system for illustration and to compare historical and computed reliability performance on an actual system.

49850 (FE—1726-17A) **Engineer, design, construct, test and evaluate a Pressurized Fluidized Bed Pilot Plant using high sulfur coal for production of electric power. Phase I. Preliminary engineering. Annual report, March 1, 1976—February 28, 1977.** (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). 15 Mar 1977. Contract EX-76-C-01-1726. 151p. (CW-WR—76-015.20A). P 08/MF A01.

Work performed from March 1, 1976 to February 28, 1977 to Engineer and Design a Pressurized, Fluidized Bed Pilot Plant using high sulfur coal for production of electric power is summarized. A conceptual design of a 500 MW commercial power plant is described. Plant efficiencies of 40% are projected. The preliminary performance and design arrangement of the PFB Pilot Plant are presented, with comparisons tabulated between the latter and the commercial plant. Also described are supporting technological test programs and results, covering heat exchanger performance and corrosion/erosion resistance of candidate materials for heat exchang-

er and turbine application. Design was completed and construction begun for the Small Gas Turbine/Pressurized Fluidized Bed (SGT/PFB) operating parameters rig which fully simulates the pilot plant operating environment. Fabrication of heat exchanger tubes, and SGT/PFB components is described.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

49851 (EPRI-FP—1096) **Optimization-simulation methodology for wet/dry cooling. Final report.** Guyer, E.C.; Brownell, D.L.; Kach, R.A. (Dynatech R/D Co., Cambridge, MA (USA)). May 1979. 235p. P 11/MF A01.

The general problems of the optimum design and operation of wet/dry cooling systems for steam-electric plants are considered in relation to electric utility system generation expansion requirements and economic operation objectives. A methodology for the economic design and a strategy for the economic operation of a wet/dry system are developed which are based on the simulation of the operation of a wet/dry plant as a component of an integrated utility system. A computer program is formulated for the simulation of the optimum operation of a heat rejection system consisting of separate wet and dry tower modules in a series flow arrangement. This computer program is applied in the case study evaluation of the design and operation of wet/dry cooling systems for a typical large fossil-fired base-load plant. Two siting situations are considered: Boston, Massachusetts and Phoenix, Arizona.

49852 **Primer on the rejection of waste heat from power plants. Consultant report.** Mitchell, R.D.; Horsak, R.D. Sacramento, CA; California Energy Resources Conservation and Development Commission (1978). 47p. (NP—23814).

Basic information is presented on why waste heat is rejectd from thermal power plants, the operation, optimization and evaluation of heat rejection systems, including cooling ponds and cooling towers, and the economic and environmental aspects of different cooling systems. (LCL)

COMPONENTS

REFER ALSO TO CITATION(S) 49430, 50282, 50297, 50351

ECONOMICS

49853 (ORNL/Sub—7384/1) **Comparative cost estimates of five coal utilization processes.** (Chem Systems, Inc., New York (USA)). Jan 1979. Contract W-7405-ENG-26. 256p. P 12/MF A01.

Detailed capital and operating cost estimates were prepared for the generation of electric power in a new, net 500 MW (e), coal-burning facility by five alternative processes: conventional boiler with no control of SO_2 emissions, atmospheric fluidized bed steam generator (AFB), conventional boiler equipped with a limestone FGD system, conventional boiler equipped with magnesia FGD system, and coal beneficiation followed by a conventional boiler quipped with limestone FGD for part of the flue gas stream. For a coal containing 3.5% sulfur, meeting SO_2 emission limits of 1.2 pounds per million Btu fired was most economical with the limestone FGD system. This result was unchanged for a coal containing 5% sulfur; however, for 2% sulfur, limestone FGD and AFB were competitive methods of controlling SO_2 emissions. Brief consideration of 90% reduction of SO_2 emissions led to the choice of limestone FGD as the most economical method. Byproduct credit for the sulfuric acid produced in regenerating the magnesia could make that system competitive with the limestone FGD system, depending upon local markets. The cost of sludge fixation and disposal would make limestone FGD noneconomic in many situations, if these steps are necessary.

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 50236

ENVIRONMENTAL ASPECTS

49854 (CONF-790737—1) **Creation of an industry information resource to catalogue power plant cooling system impacts and mitigation measures affecting aquatic and terrestrial ecosystems.** Hannon, E.H.; D'Angelo, L.J.; Talmage, S. (Atomic Industrial Forum, Inc., Washington, DC (USA); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 5p. P 02/MF A01.

From Mitigation symposium; Ft Collins, CO, USA (17 Jul 1979).

The data base design and scope, as well as the products and services offered, for the Cooling Systems Effects Data Base are summarized.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 49853

49855 (ANL/EES-TM—54) **Issues relating to new source performance standards for industrial steam generators.** Streets, D.G.; Speciner, T.A. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 155p. P 08/MF A01.

Issues relating to the revision of New Source Performance Standards (NSPS) for industrial boilers are identified. The objective is to provide information for the Department of Energy in order that it can participate productively in this standard-setting activity. The study had the following aims: to review the existing data relevant to industrial NSPS; to draw up possible regulatory alternatives; to project the effects of these regulatory alternatives; to identify issues that may be of concern to the Department of Energy; and to suggest areas for additional work. This is not a technology evaluation, nor a work plan for the Department of Energy. However, the items reported should be useful in identifying the technical issues that need to be resolved and in guiding further analysis by the Department of Energy.

49856 **Controlling oxides of nitrogen.** Cichanowicz, J.E. *EPRI J.;* **4**: No. 5, 22-27(Jun 1979).

With control technologies fully developed for particulate matter and sulfur dioxide, it appears that more regulatory attention will be directed to controlling oxides of nitrogen. The health effects are not exactly defined, but the requirement has been that no more than 0.7 lb of NO/sub x/ be emitted for every million Btu of heat released. In May 1979, though, a new maximum is set at 0.6 or 0.5 lb, depending on coal properties. Formation of NO/sub x/, combustion practice, and emergence of NO/sub x/ controls are discussed. Now in units for NSPS (New Source Performance Standards) compliance, emissions are in the range 0.5 to 0.7 lb/10^6 Btu, depending on furnace design and coal properties. Two current equipment developments (Distributed-Mixing Burner and the Primary Combustion Furnace) provide the potential for emissions as low as 0.2 lb/10^6 Btu. No/sub x/ control equivalent to levels as low as 0.10 lb/10^6 has been promulgated for California's South Coast Air Basin, to be implemented in the early 1980s. To meet these more stringent standards, the postcombustion flue gas treatment (FGT) process is being studied. The process, its cost benefits, and the development of pilot facilities are briefly discussed. (MCW)

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 49849, 50239

49857 (COO—4206-8) **Security assessment of power systems including energy storage. Progress report, January 1, 1979—March 31, 1979.** Carroll, D.P.; Triezenberg, D.M. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering). Apr 1979. Contract EC-77-S-02-4206. 4p. P 02/MF A01.

A parameter estimation algorithm has been found which, theoretically, is capable of on-line operation. It has been implemented and the implementation has been confirmed by performance on simple first and second order systems. However, convergence has not been obtained for higher order systems.

49858 (EPRI-WS—77-60) **Power system reliability: research needs and priorities.** Bhavaraju, M.P. (Electric Power Research Inst., Palo Alto, CA (USA)). Oct 1978. 309p. (CONF-780397—). P 14/MF A01.

From Workshop on power system reliability-research needs and priorities; Pacific Grove, CA, USA (5 Mar 1978).

The objective of this workshop was to identify the specific needs and priorities for research on power system reliability. The focus of the workshop was reliability evaluation for system planning rather than individual component design or availability analysis. A separate abstract was prepared for each of the 26 papers presented at the workshop for the data base.

49859 (EPRI-WS—77-60, pp 2.1-2.9) **Current research in adequacy assessment of bulk power supply systems.** Clements, K.A. (Worcester Polytechnic Inst., MA); Ringlee, R.J. Oct 1978.

From Workshop on power system reliability-research needs and priorities; Pacific Grove, CA, USA (5 Mar 1978).

Final results are reported for a program concerned with developing methodologies for bulk power supply adequacy assessment. Several areas of research are covered including network modeling, load modeling, outage modeling, load curtailment algorithms, and critical contingency selection. Network models of varying degrees of complexity are presented and the implications of the modeling assumptions are discussed. The computational requirements associated with these models are also considered. Load

models which have been developed for both system loads and bus loads are described as well as some examples using utility load data. Application of these load models to bulk power supply adequacy evaluation is described. The use of mathematical programming methods to determine remedial or corrective action including generation redispatch and load curtailment to relieve line overloads is discussed for various network models. Because of the vast number of generation and line outage contingencies which can occur in a bulk power supply network, a fast method of detecting the critical contingencies is needed. One such method which is described has been developed for ranking contingencies by their effect on the network. Several of the many areas of future research which have evolved from the current study are suggested.

49860 (EPRI-WS—77-60, pp 2.30-2.38) **Methodologies for power system reliability evaluation.** Wu, F.F. (Univ. of California, Berkeley). Oct 1978.

From Workshop on power system reliability-research needs and priorities; Pacific Grove, CA, USA (5 Mar 1978).

The state of the art of methodologies for power system reliability evaluation that incorporates transmission systems is reviewed. A unified conceptual model for power system reliability evaluation is presented. Different methods are classified within the model into three categories. Some useful concepts from reliability theory are presented, and recent progress in communication network reliability evaluation that has successfully utilized these concepts is reviewed. Future research needs in the development of methodologies for power system reliability evaluation are pointed out.

49861 (EPRI-WS—77-60, pp 4.10-4.14) **Data base requirements for bulk power system reliability evaluation.** McCoy, M.F. (Bonneville Power Administration, Portland, OR). Oct 1978.

From Workshop on power system reliability-research needs and priorities; Pacific Grove, CA, USA (5 Mar 1978).

Probabilistic reliability criteria are a suitable long-range goal to guide research on the reliability evaluation of electric power systems. The attainment of this goal involves the resolution of two broad questions: the cost of providing or not providing various levels of reliability, and the identification of all failure modes with sufficiently high expected adverse consequences. The data required to identify and analyze system failure modes and their consequences are discussed.

AC SYSTEMS, EHV AND UHV

49862 (CONS—3007-T2) **Advanced concepts for a 1200 kV shunt reactor. First quarterly progress report, 28 September 1978—31 December 1978.** (Westinghouse Electric Corp., Muncie, IN (USA). Large Power Transformer Div.). 1978. Contract ET-78-C-01-3007. 14p. P 02/MF A01.

The objective of this program is to explore new concepts for inductive shunt reactor designs for integration into a 1200 kV gas-insulated substation. The most promising design must exhibit low dimensional profile with reduced weight, lower losses, lower noise level and smaller amplitude of vibration when compared with the units of equivalent rating built with the present day technology. The planning and organization of this research program are described.

49863 (EPRI-EL—596) **Midterm simulation of electric power systems. Final report.** Gelopulos, D.P. (Arizona State Univ., Tempe (USA). Dept. of Electrical Engineering; Arizona Public Service Co., Phoenix (USA)). Jun 1979. 211p. P 10/MF A01.

The results for all phases of project RP-745 are presented. The purpose of the research was to devise efficient algorithms for simulating power systems during post fault transients and for extended periods up to 4 min. beyond the usual transient period with both long term models and interunit oscillations represented. These algorithms have been fully verified by testing on a large scale computer program which was delivered to EPRI during the course of the research. This program is of production grade quality when used for transient simulations and has been thoroughly tested during extended simulation. Techniques which have been incorporated into the program include the following: simultaneous solution of the subsystem differential equations and network algebraic equations using Newton Raphson techniques and highly stable numerical integration techniques; use of different step size for models with different inherent speed of response; and a network reduction scheme which reduces the size of the network while retaining the primary effect of nonlinear loads. In addition, an experiment was conducted to investigate the effect of simplifying generator subsystem models during the extended period of simulation. The programs have been thoroughly documented in EPRI manuals numbered EL-597 through EL-603.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 50295, 50328

49864 (ANL-PMS—79-2(Vol.11)) **World Energy Data System (WENDS). Volume XI. Nuclear fission program summaries.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 345p. P 15/MF A01.

Brief management and technical summaries of nuclear fission power programs are presented for nineteen countries. The programs include the following: fuel supply, resource recovery, enrichment, fuel fabrication, light water reactors, heavy water reactors, gas cooled reactors, breeder reactors, research and test reactors, spent fuel processing, waste management, and safety and environment. (JWR)

49865 (DOE/ET—0030/2(79)) **U.S. central station nuclear electric generating units: significant milestones (status as of April 1, 1979).** (Department of Energy, Washington, DC (USA). Div. of Nuclear Power Development). Jun 1979. 33p. P 03/MF A01.

Construction and operational milestones are tabulated for U.S. nuclear power plants. Data are presented on nuclear steam supply system orders.

49866 (IBK—1422) **Notes on organization of nuclear power station construction.** Marsicanin, B. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1977. 13p. (In Serbian). U 02/MF A01.

After a visite to some European nuclear power stations under construction and in operation, in this report a short general view on this subject is given. The progress in this in large, industrialised countries is considered as well as the relevant experience in developing countries. The new role of nuclear research institutes during construction and operation is pointed out and prospects of this cooperation evaluated.

49867 (JPRS—73575) **Translations on Eastern Europe. Scientific Affairs, No. 630.** 31 May 1979. Translation of various articles. 38p. C .

The serial report contains articles concerning the development of and progress in the various theoretical and applied scientific disciplines and technical fields; and the administration, structure, personnel, and research plans of leading East European scientific organizations and institutions, particularly the academies of sciences.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 50011, 50071, 50088, 50089, 50095, 50097, 50100, 50101, 50102, 50104, 50109, 50112, 50125, 50133, 50136, 50138, 50320, 50326

49868 (DNS-D—1-019) **Chemical cleaning of the corrosion fatigue loop at Dresden-1. Volume 1, Sections 1—6.** (Dow Chemical Co., Midland, MI (USA)). 26 Aug 1978. Contract EY-76-C-02-4014. 190p. P 09/MF A01.

Dresden Unit-1 (Dresden-1) of the Commonwealth Edison Company (CECo) has been in operation since 1960. During these years of service, radiation levels throughout the unit have continuously risen. It was realized that this radiation was rapidly approaching undesirable magnitudes. CECo requested that prior to attempting to chemically clean the entire primary system of Dresden-1, a test under actual field conditions be completed. This test would: (1) verify the effectiveness of NS-1 solvent, (2) evaluate the corrosion rates of the metals in the system, (3) observe the return of the system to service, and (4) acquaint non-CECo personnel with CECo's required procedures. Valid representation of the existing conditions at Dresden-1 became the major criterion for the selection of a representative system to chemically clean as a test. The choice was to chemically clean the General Electric Task K Corrosion Fatigue Test Loop (the Loop) on the B steam generator of Dresden-1. The Loop was selected for use in the field test because it had been exposed to actual Dresden-1 conditions, and contained deposits similar to those expected to be present in the primary side of the reactor. The decision was made to use an existing Dow Skid (the Skid), containing the equipment necessary to circulate solvent in the Loop. In order to extend the results of the pilot study to other reactors, a Spool Piece was fabricated and installed in the Loop. It would contain sections of 4" diameter stainless steel (SS) pipe from the Dresden Units 2 and 3, Quad Cities-2, and Monticello. A mock-up of a Reactor Vessel Safe End (the Safe End) was installed as part of the Spool Piece. The cleaning of the Loop and test pices is described.

49869 (EPRI-NP—1073) **Generalization of the ARMP depletion capability: interfacing of the stand alone EPRI-CINDER with EPRI-CELL. Final report.** Stamatelatos, M.G.; Chipman, M.A. (Science Applications, Inc., La Jolla, CA (USA)). Jun 1979. 152p. P 08/MF A01.

An automated interface between EPRI-CELL, a reactor cell analysis code, and EPRI-CINDER, a point depletion and fission-product code, has been generated for use in the Advanced Recycle Methodology Program (ARMP) system. This enables an efficient sequential operation of the two codes without direct handling of intermediate CELL output that is used to modify the CINDER input at each depletion time step. This alternative to the existing CELL internal depletion capability provides means for new and better application of these codes to wider areas of nuclear problems. The stand-alone EPRI-CINDER code has also been provided with new capabilities and has been modified to accept a simpler optional input structure.

49870 (INIS-mf—4492, pp v) **Computer methods used in the complex structural analysis of a drywell structure.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49871 (INIS-mf—4492, pp v) **Analysis of G.E. Mark III containment system drywell structure.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The analysis of the drywell structure in the G.E. Mark III containment system is presented and the loadings and solution techniques are discussed in this paper. The analysis is carried out by finite element techniques by using the NASTRAN computer program. In the general analysis, the drywell is idealized by triangular and quadrilateral plate elements. Due to symmetry, only half of the structure is modeled. The vent region is modeled by quadrilateral sandwich plate elements. To take into account the reduction of stiffness due to the presence of the vents a separate finite element analysis was performed. A typical segment of the plate with the vent at its middle is idealized into small finite elements. It is then subjected to prescribed displacements at its boundary in such that one overall strain component of the plate is unity and all other strain components are zero. The force necessary to hold the plate in this deformed configuration is used to calculate the stress and thus establish the reduced elasticity matrices of the plate with a hole at its middle. The reduced elasticity matrices are later used as material property input for the sandwich plates in the vent region. The stress distributions around the vents and forces or moments at the vicinity of large openings were investigated by applying the results obtained from the global analysis as boundary conditions to separate finite element models. A procedure used to analyze the drywell structure is described. The method saves considerable computer time as well as modeling time. Furthermore, the analytical results are in sufficient detail that it can be used directly for design.

49872 (INIS-mf—4492, pp v) **Structural analysis for safety relief valve discharge loads.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49873 (INIS-mf—4492, pp v) **BWR containment analysis for safety relief valve loads.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49874 (INIS-mf—4492, pp v) **Soil-structure interaction for transient loads due to safety relief valve discharges.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49875 (NUREG/CR—0330) **Ex-reactor determination of thermal gap and contact conductance between uranium dioxide: zircaloy-4 interfaces. Stage I: low gas pressure.** Garnier, J.E.; Begej, S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 218p. (PNL—2696). P 10/MF A01.

A study of thermal gap and contact conductance between depleted uranium dioxide (UO_2) and Zircaloy-4 (Zr4) has been made utilizing two measurement apparatuses developed as part of this program. The Modified Pulse Design (MPD) apparatus is a transient technique employing a heat pulse (laser) and a signal detector to monitor the thermal energy transmitted through a UO_2/Zr4 sample pair which are either physically separated or in contact. The Modified Longitudinal Design (MLD) apparatus is a steady-state technique based on a modified cylindrical column design with a self-guarding sample geometry. Description of the MPD and MLD apparatus, data acquisition, reduction and error analysis is presented along with information on specimen preparation, thermal property and surface characterization. A technique using an optical height gauge to determine the average mean-plane of separation between the simple pairs is also presented.

49876 (NUREG/CR—0331) **Effects of fill gas composition and pellet eccentricity: comparison between instrumented fuel assemblies IFA-431 and IFA-432.** Cunningham, M.E.; Williford, R.E.; Hann, C.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 52p. (PNL—2729). P 04/MF A01.

Two 6-rod, instrumented test assemblies, designated IFA-431 and IFA-432, were designed to study the effects of fabricated fuel - cladding gap size, fuel density and stability, fill gas composition, linear heat rate, and burnup. Rod 4 of each assembly was designed to study the effects of fuel - cladding geometry and minimum gas thermal conductivity upon heat transfer across the gap between the fuel and cladding. To accomplish this, mechanical restraint was used to form a concentric fuel - cladding geometry in the upper end of the rod, and an eccentric geometry in the lower end of the rod; the rod was then backfilled with xenon gas. The eccentric fuel region of the xenon rod was observed to have lower fuel temperatures, for equal power, than the concentric fuel region. It is concluded that fuel - cladding eccentricity enhances the azimuthal average gap conductance, thus reducing the fuel centerline temperature. The xenon-filled rods were compared to rods backfilled with helium. As expected, the xenon rods had higher fuel temperatures than the helium-filled rods in the assemblies, although not as high as was initially predicted. It is concluded that the reduced temperatures (relative to the predicted temperatures) were the result of a greater decrease in fuel - cladding gap size than is predicted to occur from thermal expansion alone. The ratio of the gap conductances for a xenon rod and a helium rod with equal operating thermal radial gaps, is equal to the ratio of the gas thermal conductivities for the two rods.

49877 (NUREG/CR—0865) **Startup data report for NRC/PNL Halden Assembly IFA-513.** Lanning, D.D.; Cunningham, M.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1979. Contract EY-76-C-06-1830. 75p. (PNL—2948). P 04/MF A01.

This report presents data from the first month of operation of IFA-513, which is a heavily instrumented 6-rod test assembly in the Halden Reactor in Norway. The assembly is jointly sponsored by the Halden Project and the Nuclear Regulatory Commission (NRC), and is part of a series of irradiation tests sponsored by the NRC to verify its single-rod fuel modeling computer programs. All the rods in the series are of the basic BWR-6 design with variations in gap size, fuel type, fill gas composition, and fill gas pressure. The first two tests in the series were IFA-431 and IFA-432. These were identical 6-rod assemblies, each containing the same variations of gap size and fuel pellet types, but operating at different power levels and burnups. The present assembly, IFA-513, is the third in the series; its 6 rods are all identical, except for variations in fill gas composition and pressure. The fourth and last assembly, designated IFA-527, is yet to be built, and will study the effects of fuel pellet cracking and relocation. The measurements made in IFA-513 and the earlier tests include: (1) fuel temperature and power (both steady-state and transient), (2) total cladding elongation, and (3) fill gas pressure. The measurements were made on a continuous basis, providing a record of their variation with both power and burnup. Along with the data, this report includes some analysis to put the IFA-513 startup data in perspective to similar data from IFA-431 and IFA-432.

49878 (NUREG/CR—0918) **Eddy-current inspection for steam generator tubing program quarterly progress report for period ending March 31, 1979.** Dodd, C.V.; Deeds, W.E.; McClung, R.W. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 12p. (ORNL/NUREG/TM—341). P 02/MF A01.

Eddy-current methods provide the best in-service inspection of steam generator tubing, but present techniques can produce ambiguity because of the many independent variables that affect the signals. The current development program has used mathematical models and developed or modified computer programs to design optimum probes, instrumentation, and techniques for multifrequency, multiproperty examinations. Interactive calculations and experimental measurements have been made with the use of modular eddy-current instrumentation and a minicomputer. These establish the coefficients for the complex equations that define the values of the desired properties (and the attainable accuracy) despite changes in other significant variables. The computer programs for calculating the accuracy with which various properties can be measured indicate that the tubing wall thickness and the defect size can be measured much more accurately than is currently required, even when other properties are varying. Our experimental measurements have confirmed these results, though more testing is needed for all the different combinations of cases and different types of defects. We

are continuing to design and construct instrumentation systems that will be used in the field.

49879 Validation of the finite element stress analysis computer program CORTES-SA for analyzing piping tees and pressure vessel nozzles. Bass, B.R. (Union Carbide Corp., Oak Ridge, TN); Bryson, J.W.; Moore, S.E. pp 9-25 of Pressure vessel and piping computer program evaluation and qualification, PVP-PB-024. Dietrich, D.E. (ed.). New York, NY; American Society of Mechanical Engineers (1977).

The finite element computer program CORTES-SA, which is basically a modified version of SAP3 with a special purpose input processor for setting up a wide variety of tee joint and reinforced pressure vessel nozzle geometries, was validated by comparison of calculated stresses and displacements with results from six experimental models. During its evolution, CORTES-SA had been worked on and modified by several different people. As a consequence no single person was intimately familiar with the entire program. Validation thus required solutions for a number of problems that might be encountered in the development and/or validation of any special purpose finite element computer program. The paper presents an account of the problems encountered and the steps taken to effect their solutions. Among the problems discussed are those resulting from nonparticipation in the original program development; incomplete documentation at all stages of the program development; the lack of complete sets of calculated output including displacements and equilibrium forces at boundary nodes for checking purposes; the absence of adequate output graphics; and the absence of a comparable computer program for cross-checking purposes. Results from the various analytical-experimental comparison studies and other theoretical check calculations are presented.

49880 Effects of location, thermal stress, and residual stress on corner cracks in nozzles with cladding. Besuner, P.M. (Failure Analysis Associates, Palo Alto, CA (USA)); Cohen, L.M.; McLean, J.L. (Teledyne Materials Research Co., Waltham, MA (USA)). pp 1-14 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The stress intensity factors (Ksub(I)) for corner cracks in a boiling water reactor feedwater nozzle with stainless steel cladding are obtained for loading by internal pressure, and a fluid quench in the nozzle. Conditions with and without residual stress in the component are considered The residual stress is simulated by means of a reference temperature change. The stress distribution for the uncracked structure is obtained from a three-dimensional finite element model. A three-dimensional influence function (IF) method, in conjunction with the boundary-integral equation method for structural analysis is employed to compute Ksub(I) values from the uncracked structure's stress distribution. It is concluded that the effects on Ksub(I) of location, thermal stresses, and residual stresses are significant and generally too complex to evaluate without advanced numerical procedures. The ulilized combination of finite element analysis of the uncracked structure and three-dimensional influence function analysis of the cracked structure is demonstrated and endorsed.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 49869, 49875, 49878, 49879, 50010, 50035, 50039, 50056, 50058, 50093, 50094, 50097, 50100, 50101, 50102, 50104, 50105, 50107, 50109, 50110, 50111, 50118, 50119, 50121, 50122, 50123, 50126, 50320, 50326

49881 (AED-Conf—78-155-011) **Technology of heavy apparatuses for nuclear power plants.** Clausmeyer, H. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 5p. (In German). (CONF-7804102—33). U 02/MF A01.

From Systems exhibition energy within the context of the Hannover fair; Hannover, F.R. Germany (19 Apr 1978).

The paper deals with: Construction of a steam generator and a pressure vessel for PWRs; design and calculation of reactor components; material selection; joint welding of thick-wall parts; quality assurance.

49882 (COO—4601-1) **Utility system cost evaluation, multi-unit CNSS/PWR comparison.** (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Dec 1978. Contract EN-78-C-02-4601. 45p. (UE/C-DOE—781229). Dep. NTIS, PC A03/MF A01.

The primary objective of this study was to develop and compare the total system economic impact of a phased, three stage CNSS implementation program, i.e., three-400 MWe (1200 MWt) units, to the installation of a single 1200 MWe (nominal) PWR into a typical USA utility system. In the preparation of this report, reference has been made to available published information directly related to CNSS and PWR capital costs. In addition, discussions have been held with B and W to obtain cost information related to certain CNSS auxiliary systems relevant to the study.

49883 (INIS-mf—4498, pp v) **Vibrational characteristics and wear of fuel rods.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Fuel rod wear, due to vibration, is a continuing concern in the design of liquid-cooled reactors. The methodology and models that are used to predict fuel rod vibrational response and vibratory wear, in a light water reactor environment, are discussed. This methodology is being followed at present in the design of Westinghouse Nuclear Fuel. Fuel rod vibrations are expressed as the normal bending modes, and sources of rod vibration are examined with special emphasis on flow-induced mechanisms in the stable flow region. In a typical Westinghouse PWR fuel assembly design, each fuel rod is supported at multiple locations along the rod axis by a square-shaped 'grid cell'. For a fuel rod /grid support system, the development of small oscillatory motions, due to fluid flow at the rod/grid interface, results in material wear. A theoretical wear mode is developed using the Archard Theory of Adhesive Wear as the basis. Without question certainty, fretting wear becomes a serious problem if it progresses to the stage where the fuel cladding is penetrated and fuel is exposed to the coolant. Westinghouse fuel is designed to minimize fretting wear by limiting the relative motion between the fuel rod and its supports. The wear producing motion between the fuel rod and its supports occurs when the vibration amplitude exceeds the slippage threshold amplitude.

49884 (INIS-mf—4498, pp v) **Nonlinear load deflection characteristics of a reactor fuel bundle.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In a seminal paper, L.L. Barinka, in J. Engineering for Industry, Nov. 1971, 1255-1260, described a coupled tubular structure model for use in calculating the transverse deflection of statically loaded reactor fuel bundles. Nonlinear factors included in his analysis are the loss of axial constraint due to tube slippage and a reduction in rotational constraint due to nonlinear spring coupling. Employing a lucid free body diagram of a bundle segment, the present study demonstrates that for bundles consisting of two tube types (the typical application in the nuclear industry) a physically realistic model for the calculation of static deformation is described by a system of N equations in N unknowns where N equals 12 rather than 16 as in Barinka's work.

49885 (JPRS—73575, pp 14-26) **Operation of steam turbines at Kozloduy atomic power station described.** Oprev, M.; Punevski, I. 31 May 1979. Translated from Energetika; No. 2, 5-10(1979).

In Translations on Eastern Europe. Scientific Affairs, No. 630.

The performance and thermodynamic specifications for the steam turbines at the Kozloduy nuclear power station are reviewed.

49886 Three-dimensional computations for stress and strain analysis of a PWR pressure vessel. Chevalier, G.; Bastien, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques); Lecourtois, Y. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). pp 7/2 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 49950, 50321, 50374, 50380

49887 (AED-Conf—78-155-036) **300 MWe THTR nuclear power plant Hamm Uentrop today.** Hoeft, K. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1978. 11p. (In German). (CONF-7804102—34). U 02/MF A01.

From Systems exhibition energy within the context of the Hannover fair; Hannover, F.R. Germany (19 Apr 1978).

The overall concept of the THTR is explained and the various phases of its construction up to the end of 1976 are briefly recalled. schematic drawings are shown to illustrate the primary gas circuit with the graphite reflector and the thermal shield. the techni-

cal data and the conceptual flow diagram are given, follwed by a brief discussion of a) reactor components (prestressed concrete vessels, steam generator, blowers, shut-down system) b) the after-heat removal system c) the reactor control system d) the secondary circuit, consisting of steam - condensate circuit, closed-cooling system and auxiliary cooling water system. Furthemore, the present state of construction is discused with a view to the fact that it becomes increasingly difficult for reactor operators and construction firms to keep to set dates.

49888 (GA-A—14858) **GT-HTGR plant maintenance studies.** (General Atomic Co., San Diego, CA (USA)). Mar 1979. Contract EY-76-C-03-0167-046. 203p. P 10/MF A01.

The progress of maintenance-related studies on the gas-turbine high-temperature gas-cooled reactor (GT-HTGR) power plant is reviewed. The studies, carried out with the support of participating utilities, are an ongoing effort during the plant conceptual and preliminary design phases. The primary objective of the GT-HTGR plant maintenance and inspection plan is to provide facilities, equipment, and component designs of reasonable cost that will yield good plant availability. It is therefore a matter of policy to design the reactor and power conversion system installation, as well as the related maintenance facilities, for practical operation for both planned and unplanned maintenance.

49889 (GA-A—15417) **HTGR Generic Technology Program. Semiannual report for the period ending March 31, 1979.** (General Atomic Co., San Diego, CA (USA)). Jun 1979. Contract EY-76-C-03-0167-065. 348p. P 15/MF A01.

This document reports the technical accomplishments on the HTGR Generic Technology Program at General Atomic during the first half of FY-79. It covers a period when the major design direction of the National HTGR Program is in the process of changing from the HTGR-SC emphasis to an HTGR-GT emphasis in the near term. The HTGR Generic Technology Program activities have been redirected to ensure that the tasks covered are supportive of this changing emphasis in HTGR applications. The activities include the need to develop a medium enriched uranium (MEU) fuel, and the need to qualify materials and components for the higher temperatures of the gas turbine plant.

49890 (IAE—2795) **NEKTAR code for calculating physical characteristics of graphite reactors with the account of neutron thermalization and fuel burnup.** Gol'tsev, A.O.; Karpov, V.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 21p. (In Russian). U 03/MF A01.

An algorithm for calculating the HTGR type reactor fuel cells is described. Under the assumption of fuel quasihomogeneity the two-group diffusion macro cross-sections are determined to be used in two- or three-dimensional calculations. A technique is outlined to analyze spatial and energy distributions of thermal neutrons with the account of neutron thermalization, fuel burnup and burnable poisons. Among those parameters determined are Ksub(infinity), THETA (thermal neutron absorption probability), ν(a number of secondary neutrons per neutron absorbed), μ (fast neutron multiplication factor), phi (resonance escape probability), Isub(ef) (^{238}U or ^{232}Th effective resonance integral) and diffusion constants. The algorithm is realized in the NEKTAR code written in FORTRAN for a BESM-6 computer. Comparative evaluations fulfilled show the possibility to make use of the code to investigate the physics of the RBMK and Beloyarsk NPP (both LWGR type) reactors.

49891 (IAE—2803) **VAK code for the physical calculation of a three-dimensional nuclear reactor in the diffusion approximation using a BESM-6 computer.** Karpov, V.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 16p. (In Russian). U 02/MF A01.

A method is described to calculate Ksub(ef) and the spatial-energy distributions of neutrons in the multizone HTGR type reactors. The diffusion algorithm is drawn in terms of the finite difference method to compute the three-dimensional elliptical equations. The numerical solution is realized by mixed iterations using the Yang-Frankel method. The algorithm is translated into action through the VAK code written in FORTRAN for a BESM-6 computer. The code does not limit the number of planes of node points along the reactor axis. When calculating in the two-group diffusion approximation the maximum number of nodes per plane is 4000. The physical model of neutron diffusion put into the VAK code can be used to calculate physical parameters of different nuclear reactors unless the diffusion approximation is valid.

49892 (INIS-mf—4498, pp v) **Contribution to fracture criteria for graphite.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The calculation of stresses and strains in graphite core components of the high temperature reactor is generally performed using the rules of linear elasticity. As a consequence, large stress concentrations are found. This effect would not be so pronounced if the analysis were done non-linearly and non-elastically. In order to make a statement about the fracture strength of the component, the largest calculated stress is compared with the strength obtained from a uniaxial tensile test specimen. This criterion is conservative in nature but inadequate to predict failure in the general case. In this paper two alternative methods to solve the problem of failure of graphite components are presented.

49893 (INIS-mf—4498, pp v) **Studies on the graphite rupture under secondary stresses.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In HTGR graphite fuel elements, stresses are mainly induced by temperature distributions which cause differential thermal and irradiations strains. In order to verify the adequacy of the fuel element design, it is necessary to compare the calculated stresses with the measured mechanical resistance of the material. Therefore, we have to define and verify failure criteria for graphite. It is always very difficult to establish stress limits in such a way that these limits do not restrict unnecessarily the design. In the case we consider, the difficulty is related to three aspects: type of material (brittle), kind of stress (secondary), large variations of properties under irradiation. The only way to resolve the difficulties is to experimentally determine the mechanical failure criteria, under conditions similar to those existing in an HTGR core. Because of the capability of graphite to withstand large thermal gradients, it is necessary to obtain very high heat fluxes. A test program has been set up at CEA where two types of experiments are performed: rupture of graphite tubes under themal grandient and rupture of graphite bodies under irradiation. The results of the detailed calculations are presented in the paper. All the stress calculations are performed with the PASTEL program of the CEASEMT system of structures analysis.

49894 (INIS-mf—4498, pp v) **Thermal-stress analysis of HTGR fuel and control rod fuel blocks in in-block carbonization and annealing furnace.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new method for performing thermal stress analyses in structures with multiple penetrations was applied to these analyses. This method couples the development of an equivalent thermal conductivity for the blocks, a technique that has been used extensively for modeling the thermal characteristics of reactor cores, with the use of the equivalent solid plate method for stress analysis. Using this equivalent thermal conductivity, which models as one material the heat transfer characteristics of the fuel, coolant, and graphite two-dimensional, steady-state thermal analyses of the fuel and control rod fuel blocks were performed to establish all temperature boundaries required for the stress analyses. In applying the equivalent solid plate method, the region of penetrations being modeled was replaced by a pseudo material having the same dimensions but whose materials properties were adjusted to account for the penetration. The peak stresses and strains were determined by applying stress and strain intensification factors to the calculated distributions. The condition studied was where the blocks were located near the center of the furnace. In this position, the axial surface of the block is heated near one end and cooled near the other. The approximate axial surface temperatures ranged from 1521°C at both the heated and the cooled ends to a peak of 1800°C near the center. Five specific cases were analyzed: plane (two-dimensional thermal, plane stress strain) analyses of each end of a standard fuel block (2 cases), plane analyses of each end of a control rod fuel block (2 cases), and a two-dimensional analysis of a fuel block treated as an axisymmetric cylinder.

49895 (INIS-mf—4498, pp v) **Residual stresses in Peach Bottom test elements analysis experiment.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Operating stresses and residual shutdown stresses in fuel test elements irradiated in the Peach Bottom Reactor were calculated with finite element methods. Calculations of deformation and stress due to primary loads were also made. Results of the calculations were used to develop an experimental analysis of graphite fuel and reflector elements. Measured deflections and fracture loads were then compared with predictions made with the analytical methods and data to be verified. Thirteen graphite bodies from eight test elements were analyzed. All of these were in the form of hollow cylinders 70 mm in diameter by 813 mm long which had six or eight fuel holes evenly spaced around the annulus. The various bodies were irradiated to fast neutron fluences between 0.3 and 4.0×10^{25} n/m^2 at temperatures between 850 and 1300°K. Residual axial stresses in the elements were calculated to reach 15.7 MPa compared to a strength of 22.8 MPa while in-plane stresses were calculated to reach

15.8 MPa compared to a strength of 11.5 MPa. For the eight-hole teledial elements, peak in-plane stresses were found to be at a sharp notch, where the stress calculations were believed to be unreliable. In-plane stresses at other locations, were the stress predictions were expected to be more reliable, reached 11 MPa. A number of experiments were designed as a result of the calculations. Portions of the fuel bodies were cut into longitudinal strips of 460 mm length. The expected bow of the strips due to the gradient in residual axial stress was calculated to range between 0.5 and 3 mm by applying elastic beam theory to the results of the residual stress calculation.

49896 (INIS-mf—4498, pp v) **Isolation and analysis of critical stress areas in graphite fuel elements.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a summary of methods being used at General Atomic for the analysis of irradiation-induced stresses in the graphite fuel elements of a high-temperature gas-cooled reactor (HTGR). The main topic of the paper is a systematic strategy for the isolation and detailed analysis of critical stress areas. The first program in the hierarchy, named SURVEY/STRESS, uses a simplified beam theory model to sort and identify potentially critical fuel elements among the thosands in the core. SURVEY/STRESS employs an idealized geometry consisting of an array of parallel fibers, each one of which is an accurate representation of the symmetrical web between the fuel and coolant holes. The program automatically superimposes the localized web stress field on the average stress fiel of the block. A more refined sorting is done with the aid of a general purpose beam theory code named GBEAM. GBEAM employs an array of triangular elements to accurately model the geometry. The calculated axial stresses are very close to those of a two-dimensional analysis, but they are obtained at a considerable cost saving. The third program in the series is SAFIRE, a two-dimensional, viscoelastic, finite element program. SAFIRE employs a generalized plane strain (GPS) element in which three global bending degrees of freedom are introduced at the element level. The GPS element correctly considers the stiffness and Poisson coupling effects of out-of-plane deformations.

49897 (INIS-mf—4498, pp v) **Rules for design of nuclear graphite core components, some considerations and approaches.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the course of the study the following topics were among those broadly investigated, and recommendations for each are presented. It was found that analytic statistical methods used to arrive at a definition of minimum ultimate strength, without considering actual experimental acceptance testing procedures for the graphite material, were totally unrealistic. A procedure is outlined which incorporates the truncation effects on the probability distribution function due to material acceptance tests, and utilizes such testing concepts to simply produce a value of minimum ultimate strength. It was concluded on the basis of presently available evidence that the distinction between secondary and primary stresses are inappropriate to graphite structures. Various arguments for promoting such a distinction are reviewed and countered. The proposed overall design criteria and stress limits for graphite structures were reviewed. It is concluded that, while much of the design basis was drawn from the ASME design criteria for metal structures, a literal adoption of numerical safety factors may not lead to equivalent safety for materials like graphite. The use of the homologous stress concept in graphite fatigue calculations was reviewed. The overall design philosophy for brittle materials is applied to HTGR core structure design including such areas as: graphite oxidation; component proof tests; experimental seismic modeling; fracture analysis.

49898 (INIS-mf—4498, pp v) **Residual stress and strain examination in Peach Bottom fuel test elements.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An examination of residual stresses and strains has been carried out experimentally on structural graphite components removed from the Peach Bottom high temperatures gas cooled reactor (HTGR) fuel elements. The purpose is to confirm predicted stress distributions. Twenty-nine teledial fuel elements (of six and eight hole design) were irradiated in the Peach Bottom HTGR to fluences of $<=4x10^{25}$ ($E>29fJ$) and time average temperatures up to $1000^{0}C$. The irradiation history was modeled with HTGR design codes. Performance predictions were verified by in-pile thermocouples and fuel burnup measurements. The predicted irradiation induced strains were found to be in quantitative agreement with post irradiation measurements ($<=0.5\%$ shrinkage over 70 mm diameter). As a result of the temperature distribution in the teledial bodies, compressive stresses were predicted at the periphery and tensile stresses in the inner zones. A total of thirteen graphite bodies from eight different fuel elements were examined destructively for structural integrity and residual stresses. For the higher exposure elements, local stresses at shutdown in excess of the uniaxial strength of the material were predicted, yet no structural damage was found. This may be because uniaxial failure criteria are conservative. Axial strips of 460 mm length were cut and measured for changes in curvature which indicate release of residual axial stresses. Release of compressive residual stresses were observed from slight extension of the strips, when compared with length measurements before cutting.

49899 (Juel-Spez—4) **Lay-out and construction of a pressure vessel built-up of cast steel segments for a pebble-bed high temperature reactor with a thermal power of 3000 MW.** Voigt, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Mar 1978. 105p. (In German). U 06/MF A01.

Thesis.

The prestressed cast vessel is an alternative to the prestressed concrete vessel for big high temperature reactors. In this report different cast steel vessel concepts for an HTR for generation of current with 3000 MW(th) are compared concerning their realization and economy. The most favourable variant serves as a base for the lay-out of the single vessel components as cast steel segments, bracing, cooling and outer sealing. Hereby the actual available possibilities of production and transport are considered. For the concept worked out possibilities of inspection and repair are suggested. A comparison of costs with adequate propositions of the industry for a prestressed concrete and a cast iron pressure vessel investigates the economical competition.

49900 (KFK—2663) **SAGAPO-2 - an improved version of the SAGAPO code for the thermofluiddynamic analysis of gas cooled fuel element bundles.** Martelli, A. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Jul 1978. 168p. (EUR—5753e). U 09/MF A01.

The SAGAPO Code, developed at the Karlsruhe Nuclear Center, was improved at General Atomic Company in San Diego, California (USA). The modifications introduced at General Atomic are summarized in this paper. Furthermore, the meaning of the new variables defined in COMMON BLOCKS is also explained. A complete listing of the new version of the code is included in Appendix. Finally, the results of a parametric study performed at General Atomic with SAGAPO are summarized in this paper. (orig.) 891 GL.

49901 (ORNL—5497) **Distribution and transport of tritium in the Peach Bottom HTGR.** Wichner, R.P.; Dyer, F.F. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 154p. P 07/MF A01.

This report completes the first phase of a two-phase effort to describe and understand tritium production and movement in an operating high-temperature gas-cooled reactor (HTGR) system. The principal objective of phase 1 is to report the findings on tritium concentrations in core components acquired during the Peach Bottom Surveillance Program, which dealt with fission product migration in general, and a follow-on task devoted specifically to tritium. Administrative procedures are being developed for the second phase of the work to be performed in the Federal Republic of Germany under the auspices of the international umbrella agreement on gas-cooled reactor (GCR) development. In this effort, computer model predictions of tritium transport in the reactor system will be compared with observed concentration levels.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

49902 (INIS-mf—4498, pp v) **Hydrodynamic mass and fluid damping of rod bundles vibrating in confined water and air-water mixtures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the past few years, a considerable effort has been devoted to increasing the understanding of fuel string vibration mechanisms in CANDU (Canadian Deuterium Uranium) reactor channels. Part of the overall program has involved the development of a mathematical model which describes fuel string dynamics in axial flow. Because of the complex bundle geometry, model input parameters such as bundle hydrodynamic mass and associated fluid damping are difficult to determine from theory, and recourse is made to experimental techniques. This paper presents the results of an experimental study conducted to determine these parameters. Assemblies of three types of 0.5 m long CANDU bundles (with fuel pellets removed to reduce weight), each comprised of two bundles clamped end to end on a central support rod, were tested in flow channels of various inside diameters. An electrodynamic shaker, mounted directly on the

flow channel, was used to sinusoidally excite the assembly at its mid-point. Driving point mobilities over a frequency range of 5 Hz to 40 Hz were computed with a transfer function analyzer from the force input and the measured lateral velocity at the mid-point of the assembly. A large number of tests was carried out with flow channels filled with air, water, and a range of air-water mixtures (0% to 30% air volume fraction). Bundle hydrodynamic mass values in water and in air-water mixtures were computed from the first mode frequency equation using the measured resonant frequency data of the assembly. The assembly stiffness was assumed to be independent of the surrounding fluid. Fluid damping values were estimated by subtracting the structural damping factor, as measured in air, from the overall damping factor.

49903 (INIS-mf—4498, pp v) **Vibration measurements on a string of CANDU-fuel bundles in adiabatic steamwater flow.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Flow induced vibration of fuel is an important consideration in the design and operation of vertical pressure tube reactors such as the CANDU-BLW (Canadian Deuterium Uranium - Boiling Light Water) reactor. Since the pressure tubes and fuel sheaths must maintain their integrity over the specified life of the component (30 years for the pressure tubes, 2 years for the fuel), fretting wear between these components must be kept to very low levels. Experimental data from tests on full scale components are required to verify the design and supply the many empiricisms required for analytical modelling of the system. For the present out-reactor test program, since void generation along the fuel was not possible, two-phase mixtures were introduced at the inlet to the channel to simulate the actual reactor outlet conditions. The test fuel string consisted of ten, 5m long, prototype 36-element fuel bundles containing natural UO_2, supported on a 13 mm diameter central structural rod with a spring tensioning device. This assembly was supported from the bottom on a long shield plug, inside a 104 mm diameter zirconium alloy flow channel. Steam from an oilfired boiler and recirculating water were mixed in a tube-in-shell mixer and the two-phase mixture passed upward through the channel and into a separator. The lateral vibrational velocity of the fuel string relative to the flow channel was measured at various axial locations with magnetic velocity transducers. These were attached to the channel opposite magnets imbedded in outer elements of the fuel bundles. The signals from these transducers were analyzed to determine their spectral content and rms displacement. The range of test parameters included mass flows up to 8700 $kg.m^{-2}s^{-1}$, qualities to 37% and channel exit pressures to 5.8 MPa. Two values of central structural rod tension were tested.

49904 (INIS-mf—4498, pp v) **Repeatable boundary conditions and their application in the analysis of a complete CANDU fuel pin.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper a simple repeatable boundary condition is introduced. This boundary condition is deduced from the fact that, for CANDU fuel pins, the power distribution along the length of the pins of interest is essentially constant, with the exception of the flux peak at each end. This is true because of the short, 50 cm length of the fuel pins, and the extensively flattened axial fluxes in the physically large CANDU reactor cores. It is therefore conceivable that the thermal/mechanical behavior of each pellet (except those near the end caps) is approximately the same. If a fuel pin is divided into regions, each region containing a number of finite elements covering one fuel pellet, then the temperature field and the displacement field can be assumed identical or repeatable for all regions. It follows that the stiffness and the thermal conductivity matrices of all regions should also be identical at any time interval. Thus the assembly of stiffness and conductivity matrices at each time step need only be performed for one typical region. The overall stiffness and conductivity throughout all regions can then be assembled from the corresponding matrix components related to each repeatable temperature and displacement unknown. Each repeatable loading term is also assembled accordingly. For the regions near the end caps, the conventional method is used in the assembly of matrices to account for the end conditions and flux peaking. The present method greatly reduces the number of equations required since all pellets not associated with the end region are represented by one equivalent pellet.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 49949, 50032, 50033, 50034, 50038, 50041, 50042, 50043, 50044, 50046, 50047, 50097, 50098, 50103, 50106, 50108, 50115, 50116, 50117, 50120, 50124, 50139, 50140, 50306, 50886, 50887

49905 (CONF-790363—2) **Evaluation of the influence of seismic restraint characteristics on LMFBR piping.** Mallett, R.H. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1979. Contract EY-76-C-15-2395. 21p. P 02/MF A01.

From US Japan specialist meeting on high temperature piping design and analysis; Pittsburgh, PA, USA (26 Mar 1979).

For the Clinch River Breeder Reactor Plant (CRBRP) heat transport system piping within the reactor containment building, dynamic analyses of the piping loops have been performed to study the effect of restraint stiffness on the dynamic behavior of the piping, i.e., changes in frequencies, mode shapes, loads, stresses, and displacements. In addition, analysis and testing of typical CRBRP restraint system components have been performed for the purpose of quantifying and verifying the basic characteristics of the restraints used in the piping system dynamic analysis. The results are presented of the analysis and testing described above. In particular, it is shown that piping restraint effects on breeder reactor piping response are important considerations in the design/analysis process.

49906 (CONF-790363—3) **Load-time histogram and elastic analysis of CRBRP heat transport system piping.** Mello, R.M. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1979. Contract EY-76-C-15-2395. 21p. P 02/MF A01.

From US Japan specialist meeting on high temperature piping design and analysis; Pittsburgh, PA, USA (26 Mar 1979).

The CRBRP heat transport system piping was designed and analyzed for the operating and load conditions as specified in the Piping Design Specification. The various types of design loading conditions have been categorized into design, normal, upset, emergency and faulted conditions, and organized into a load histogram. Using the thermal transient defined for each condition and the histogram, a set of load cycles was constructed using the 863 startup-shutdown conditions. The stress analysis of the piping was performed on the basis of the thermal transients and loadings resulting from the loading categories and the histogram. The ELTEMP computer program was used to perform the elastic ASME Code compliance analysis. The input required to perform the Code evaluation included the pipe cross-section geometry, component type (elbow, tee, straight, etc.), the forces and moments output data from the flexibility analyses, average temperature, linear temperature gradients, non-linear temperature gradients, pressure, etc.

49907 (CONF-790363—4) **Application of ASME Code Case N-47 concepts to CRBRP primary piping.** Mallett, R.H. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1979. Contract EY-76-C-15-2395. 22p. P 02/MF A01.

From US Japan specialist meeting on high temperature piping design and analysis; Pittsburgh, PA, USA (26 Mar 1979).

Portions of document are illegible.

Section III of the ASME Code provides rules in Subsection NB-3600 which greatly simplify the structural evaluation of piping. The key to this simplification is in the use of stress analysis formulas based upon stress indices. These formulas are applicable in the evaluation of compliance with limits on elastically calculated quantities. At present, Code Case N-47 permits, but does not specify, the use of analyses based upon piping stress indices. This paper describes a set of formulas for piping analysis using stress indices. Specifically, stress intensities needed for evaluation of compliance with Code Case N-47 limits on elastically calculated are given using piping stress indices. The specified formulas are examined by comparison with related ANSI B31.1 rules and test data.

49908 (CONF-790615—16) **Design considerations for CRBRP heat transport system piping operating at elevated temperatures.** Pollono, L.P.; Mello, R.M. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1979. Contract EY-76-C-15-2395. 27p. P 03/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

The heat transport system sodium piping for the Clinch River Breeder Reactor Plant (CRBRP) within the reactor containment building must withstand high temperatures for long periods of time. Each phase of the mechanical design process of the piping system is influenced by elevated temperature considerations which include material thermal creep effects, ratchetting caused by rapid temperature transients and stress relaxation, and material degradation effects. The structural design philosophy taken to design the CRBRP piping operating in a high temperature environment is described. The resulting design of the heat transport system piping is presented along with a discussion of special features that resulted from the elevated temperature considerations.

49909 (CONF-790731—1) **Charged particle irradiations in the United States Breeder Reactor Program.** Rowcliffe, A.F.; Lee, E.H.; Sklad, P.S. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 24p. P 02/MF A01.

From US/USSR breeder reactor core materials information exchange meeting; Richland, WA, USA (Jul 1979).

Charged particle irradiations used as a means of studying radiation damage in materials of interest in the US Breeder Reactor Program are reviewed.

49910 (ECN—41) **Fast reactor programme. Fourth quarter 1977 progress report.** Hoekstra, E.K. (Stichting Energieonderzoek Centrum Nederland, Petten). May 1978. 67p. U 04/MF A01.

Fast neutron capture cross section data of natural Mo are presented; a feasibility study on integral neutron spectrum measurements in the low-energy region of large LMFBR's is discussed. The post-irradiation examination results of the fuel pin of loss-of-cooling experiment R63-L18 and the progress made with preparations for the HFR-TOP transient overpower experiments on fuel pins under irradiation in the pool-side facility of the HFR are reported on. An exact determination of the thermochemical properties of uranyl halides is discussed. Results of mechanical tests on stainless steel DIN 1.4948 specimens are given. Aerosol leakages through blocks of concrete are determined. In the field of heat transfer and hydraulics, data on fully-developed turbulent flows in rod bundles have been obtained using the code VITESSE, results of Laser Doppler Anemometer measurements performed on water flowing through a square channel are given and progress is reported on the study of local boiling occurring behind a flow blockage in a 28-rod bundle.

49911 (FEI—677) **Study on conditions of testing of fast reactor fuel assemblies in a thermal research reactor. Part1. Investigation method.** Kulikov, Yu.N.; Lantsov, M.N.; Kozlovtsev, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1976. 14p. (In Russian). U 02/MF A01.

Considered is the method for studying conditions of the loop tests of the fast reactor fuel element assemblies in the thermal research reactor. Presented is the method of conversion of the fuel element assembly into a cylinder with homogeneous distribution of the assembly components, the non-uniform distribution of heat-evolution areas and the full power of the assembly being preserved. Obtained were the relationships showing dependence of the non-uniform distribution of the heat-evolution areas and power of the loop assembly on the assembly composition and dimensions.

49912 (GA-A—14820) **GCFR irradiation experiments.** (General Atomic Co., San Diego, CA (USA)). Oct 1978. Contract EY-76-C-03-0167-023. 49p. (CONF-790306—17). P 03/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

The fuel rods in the gas-cooled fast breeder reactor (GCFR) are vented and pressure equalized to avoid creep collapse of the cladding under external overpressure of 9 MPa (90 atm) of the helium coolant. The GCFR thermal flux mixed oxide fuel rod tests consisted of sealed rod experiment P-8 and vented rod sweep gas capsule experiments GB-9 and GB-10 in ORR. The GCFR epithermal flux tests include planned single-rod vented sweep gas experiment GB-11 and the helium loop tests of 12-ribbed-rod, vented bundle tests HELM 2 (UO_2 fueled) and HELM 3 (PuO_2—UO_2 fueled), which are currently under way. The GCFR fast flux experiments consist of 13 encapsulated rods (7 rods at a time) in F-1 (X094), 10 encapsulated rods in F-3 (X206), and 43 unencapsulated rods (31 rods at a time) in the F-5 (X317) grid spaced bundle experiment. The objectives of the GCFR irradiation tests are given.

49913 (GEFR—00424) **Physicochemical model for predicting sodium reaction swelling in breached LMFBR fuel and breeder elements.** Caputi, R.W.; Adamson, M.G.; Evans, S.K. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Mar 1979. Contract EY-76-C-03-0893-031. 48p. AT.

The use of sodium as a coolant for the Liquid Metal Fast Breeder Reactor (LMFBR) necessitates study of the properies of the coolant and chemical interactions it may undergo with the reactor fuel. If a defect or breach develops in the cladding of an irradiated fuel pin, sodium is likely to enter the pin and react chemically with the fuel. This reaction results in formation of a sodium-fuel reaction product which, since it has a lower density than the fuel, can cause the fuel pin to swell. An investigation is presented for the reaction of sodium with the mixed-oxide fuel following a breach of the cladding. Predictive correlations are presented for swelling with time in breach fuel rods that will be helpful to those concerned with performance of breached driver fuel pins and blanket rods in an LMFBR and plant-related consequences.

49914 (GEFR—00436) **FULMIX-II: a computer program for steady-state thermal-hydraulic analysis of wire wrapped rod bundles.** Wei, J.P. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). 1 Mar 1979. Contract EY-76-C-03-0893-031. 250p. AT.

This report provides a description of the FULMIX-II computer program, detailed instructions for its use, and a brief discussion of the features of the program. FULMIX-II is a modified version of FULMIX [I]. FULMIX-II is designed specially to determine single-phase, steady-state coolant flow and temperature distributions in a wire wrapped assembly with reference wire wrap design (straight starts) and other wire wrap configurations (staggered starts, wireless rods, locked wrap, etc.). The code can be used for hexagonally arranged assemblies with 7 to 271 fuel rods. The code performs the steady-state calculation of average temperatures for each fuel rod and coolant flow subchannel in the assembly at an arbitrary number of axial planes. The thermal—hydraulic analyses presented in this report are based on application of the subchannel concept in association with the use of bulk parameters for coolant velocity and coolant temperature within a subchannel. The interactions between subchannels are due to turbulent interchange, pressure-induced crossflow, directed sweeping crossflow induced by the helical wire wrap, and transverse thermal conduction. Flow field in the pin bundle is solved first using an iterative method in a finite difference scheme. Once the flow field is determined, the energy equation is decoupled, and the temperature distribution is calculated accordingly.

49915 (GEFR—00445) **Analysis of the ZPPR-8 critical experiments.** Lu, Y.S.; Crick, S.C. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Mar 1979. Contract EY-76-C-03-0893-031. 83p. AT.

The purpose of this report is to present the analysis of a series of experiments performed in the Zero Power Plutonium Reactor (ZPPR), identified as ZPPR Assembly 8. This assembly simulates a clean condition of the demonstration-reactor class LMFBR core with a heterogeneous (radial parfait) reference configuration which uses thorium in the internal blanket regions. The experimental program in ZPPR-8 was specified to provide a benchmark study of the neutronic behavior of a heterogeneous LMFBR core with an emphasis on the impact of a thorium blanket. A thorium blanket was loaded at different locations for various phases of ZPPR Assembly 8. This report presents details on the experimental program, criticality, core midplane reaction rate distributions, sodium void and subassembly worth measurements, control worth measurements and loading error simulations, and finally the conclusions.

49916 (HEDL—6522) **Introduction to breeder reactors.** (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1979. Contract EY-76-C-14-2170. 65p. AT.

Information is presented concerning the characteristics of breeder reactors; the role of the breeding cycle; types of breeders and breeding cycles; and design considerations.

49917 (HEDL-SA—1579) **In-reactor performance of methods to control fuel-cladding chemical interaction.** Weber, E.T.; Gibby, R.L.; Wilson, C.N.; Lawrence, L.A.; Adamson, M.G. (Hanford Engineering Development Lab., Richland, WA (USA); General Electric Co., Vallecitos, NM (USA)). 1979. Contract EY-76-C-14-2170. 15p. (CONF-790306—15). P 02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

Inner surface corrosion of austenitic stainless steel cladding by oxygen and reactive fission product elements requires a 50 μm wastage allowance in current FBR reference oxide fuel pin design. Elimination or reduction of this wastage allowance could result in better reactor efficiency and economics through improvements in fuel pin performance and reliability. Reduction in cladding thickness and replacement of equivalent volume with fuel result in improved breeding capability. Of the factors affecting fuel-cladding chemical interaction (FCCI), oxygen activity within the fuel pin can be most readily controlled and/or manipulated without degrading fuel pin performance or significantly increasing fuel fabrication costs. There are two major approaches to control oxygen activity within an oxide fuel pin: (1) control of total oxygen inventory and chemical activity (Δ anti GO_2) by use of low oxygen-to-metal ratio (O/M) fuel; and (2) incorporation of a material within the fuel pin to provide in-situ control of oxygen activity (Δ anti GO_2) and fixation of excess oxygen prior to, or in preference to reaction with the cladding. The paper describes irradiation tests which were conducted in EBR-II and GETR incorporating oxygen buffer/getter materials and very low O/M fuel to control oxygen activity in sealed fuel pins.

49918 (HEDL-TME—78-21) **Sodium engineering and technology. Technical progress report, April, May, June 1978.** Atwood, J.M. (comp.). (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1978. Contract EY-76-C-14-2170. 146p. AT.

This report presents a quarterly summary of progress made at Westinghouse Hanford Company in the areas of radioactivity control technology, sodium systems technology, safety systems development, and hydraulics and mechanics.

49919 (INIS-mf—4498, pp v) **Parametric investigation of dynamic fracture.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents results of parametric finite element fracture mechanics analyses conducted to develop an analytical model

for simulating dynamic brittle fracture. Although this work may have wider general application, the dynamic loads considered here are those that may arise due to rapid release of fission gases from a failed fuel element inside a subassembly duct in an LMFBR. The analyses were conducted on an edge-cracked panel with various configurations of primary and secondary flaws similar to those investigated for quasi-static fracture earlier by Chopra, et al. The dynamic loading was in the form of a triangular pressure pulse which reached a peak value of 1000 psi in 0.1 msec and decayed to zero in 2.0 msec. The finite element mesh employed was identical to that used for previous quasi-static fracture investigations so that the dynamic and quasi-static results could be compared. For the fracture configurations analyzed, the peak dynamic crack opening stresses (COS) in the vicinity of the crack tip exceeded the static values by factor of approximately 1.5. The displacement between two opposing nodes behind the crack tip, called the crack opening displacement (COD), also was investigated. The dynamic COD was found to be approximately 1.3 times greater than the corresponding static value. This difference may be due to the different locations at which the quantities are computed.

49920 (INIS-mf—4498, pp v) **Two-dimensional heat conduction calculations on the pin cladding and coolant of a wire wrap bundle.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49921 (INIS-mf—4498, pp v) **LMFBR fuel assembly channel wall cross section optimization.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An LMFBR fuel assembly channel is a hexagonal thin-walled tube surrounding the fuel pin bundle to facilitate fuel handling and to control the flow of coolant through the core. The channel is subject to the internal pressure of the high temperature sodium coolant and also to a high flux of fast neutrons. This environment results in a ballooning of the channel from its original hexagonal shape due to irradiation swelling, thermal and irradiation enhanced creep, and the elastic pressure deformation of the channel material. The cross-sectional shape of the hexagonal channel is limited primarily by the principal stress and the total channel radial growth. It is presently considered preferable that adjacent channels do not touch from channel ballooning due to concerns about safety and refueling considerations. A computer program, WALLOP, has been developed as described in this paper to derive the wall shape of such an optimum channel, given realistic design and material constraints. Within WALLOP, an initial cross-sectional shape is chosen and a beam model of the wall is used to determine the elastic deflection. By assuming any changes in the axial direction along the assembly length to be gradual, a transverse slice of one wall may be reduced to a variable thickness, plain-strain, fixed-end beam with a non-planar centroidal surface and subject to transverse loading (internal coolant pressure) and axial loading (hoop force constraining the internal pressure). The deflection is combined with swelling and creep rate data on the chosen wall material and with core geometric parameters to evaluate the time for channel-to-channel contact. The computer program then sequentially perturb the wall cross section and repeats the process until channel life is maximized. This sequential search optimization process is similar to the 'Rosenbrock' algorithm.

49922 (INIS-mf—4498, pp v) **Computer analysis of the influence of design parameters, materials properties and operation conditions on the irradiation behavior of fast breeder fuel rods with oxide fuel.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Irradiation experiments have shown that clad deformations due to contact pressure have occurred starting at a certain burnup value. This threshold is determined by two processes: time to gap closure and succeeding stabilization of the outer fuel region by crack healing. Irradiation experiments and modeling analyses have revealed that the gap volume is exhausted faster than expected due to fuel swelling only. Reasons for this effect are: formation of fission gas bubbles and their migration towards the central hole with simultaneous dislocation of the fuel pellet towards the clad and/or relocation of the cracked fuel pellet, e.g. due to power changes during reactor operation. It is known, moreover, from experiments and modeling analyses that high contact pressures and resulting clad deformations occur at non-steady-state operation. Necessary conditions are: residual gap width smaller than the difference between the thermal expansion of fuel and clad, sufficient degree of crack healing, and increase of the local rod power above the level maintained a certain time. Contact pressure and clad deformation are determined by following parameters: start and end level of the rod power, the power ramp, the mechanical stability of the fuel which is influenced by its density and crack structure and volume, and creep and/or plastic properties of fuel and clad which are governed by temperature and rod power. SATURNE-1 calculations have shown that the load onto the clad expected at power ramps depends heavily on three factors: thermal expansion of the fuel pellet (dependency on O/Me ratio, actual temperature level) healing of the peripheral radial cracks, and mechanical properties of the outer fuel region.

49923 (INIS-mf—4498, pp v) **Three-dimensional analysis for fuel pin deformations in an LMFBR assembly.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Based on this method, a new computational code, the Subchannel Deformation Analysis Code for Wire-Wrapped Assemblies (SHADOW), has been developed, which can be applied to seven kinds of wire-wrapped fuel assemblies with a number of fuel pins ranging from 7 to 169. This code calculates subchannel flow areas, wetted perimeters, gaps between fuel pins and distances between the outermost pins and wrapper tube wall, coupled with a thermal hydraulic code in order to get the temperature distributions of coolant and cladding in the deformed flow channels. SHADOW also calculates the magnitudes, positions and directions of contact forces loaded by the adjacent fuel pins or wrapper tube. SHADOW was utilized for analyzing the deformation due to thermal bowing of 169 fuel pins in a prototype fast breeder reactor. Conclusions derived from the present study are summarized as follows: the bowing deformations are significant throughout the overall length of the outer fuel pins and in the upper part of the gas plenum region of the inner fuel pins. These phenomena cause the axial variations of the flow areas, especially, in the outer channels and requires iterative estimations of the temperature distribution in the deformed channels. In the case of the outer fuel pins, the major contact forces are loaded near the top of each fuel pin, and in the case of the inner ones, the loads are mainly applied near the center parts of the gas plenum and core regions. These forces are not large enough to deform the cross section of the cladding.

49924 (INIS-mf—4498, pp v) **Response of a grid spaced fuel assembly to shipping environment.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a dynamic analysis approach for design verification of the GSA under conditions of shipping and handling using prototypical test examples of transportation by truck. Analytical response results were obtained using representative trailer bed acceleration time histories which had been recorded earlier under simulated shipping by truck transport environment. Important parameters affecting response are identified. Recognizing that the analytical estimate of the fundamental periods of the GSA cannot be very accurate owing to the complex geometry, upper bounds on acceleration reponses were established using the standard response spectrum technique. Finally, the GSA design was verified by laboratory tests-both static and dynamic. Static tests were used to calibrate displacement response of the grid spacer tabs relative to the fuel rods. Prototypical dynamic shaking table test were next employed in which the response of the GSA was determined in sinusoidal sweep type of excitation. Handling loads were represented by shock tests consisting of one-cycle impulses at various levels of acceleration. The results of laboratory testing were seen to reinforce credance of design verification by analysis of the GSA subjected to shipping and handling environment.

49925 (INIS-mf—4498, pp v) **Stress-intensity factors for irradiation-embrittled hexagonal subassembly ducts.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The results of a finite-element analysis of the same problem are reported, and they support the applicability of beam theory to the hexcan problem. In particular, modelling the hexcan corner as a cracked strip whose crack faces are loaded with the hexcan stress distribution has been found to give very good results for the particular hexcan studied. The finite-element results for uniformly pressurized hexcans have been used as the basis for computing stress intensity factors for cracks in non-uniformly loaded hexcans, under loading conditions that might simulate those of fission gas released from failed fuel pins or other non-uniform accident loading conditions. The weight function technique employed can be used to study a variety of conditions in a quick and efficient manner, for all that is required is knowledge of the stress intensity factor of the reference problem of the uniformly-loaded hexcan and the stress distribution through the thickness of an unflawed hexcan. This information is used in conjunction with a simple representation for the crack shape, and it is shown how one may thereby compute stress intensity factors for other loading conditions by the evaluation of simple integrals. The technique is illustrated by the problem of a hexcan loaded by concentrated forces at opposite midflats. A finite-element

analysis also has been carried out for the cracked hexcan loaded by midflat forces. The results of the different techniques are compared, and the simple model of a cracked strip loaded with the hexcan stress distribution is found again to agree closely with the finite-element results for the hexcan considered. However, the weight function technique is expected to apply to geometries for which the strip model is inadequate and to hold over a wider range of crack sizes.

49926 (INIS-mf—4498, pp v) **Model for pressure in an LMFBR duct due to discharge of gas from a failed fuel pin.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper an analytical model for the calculation of pressure pulses in hexagonal ducts due to discharge of gas from a failed fuel pin is developed. The analysis yields the time history of the pressure pulse which can be used in the calculation of permanent deformation of the duct or in the assessment of the susceptibility of the duct to fracture. The real physical situation of gas discharging through a pin in a duct filled with liquid is complex to model. Here the phenomenon is modeled based on some reasonable assumptions. In this model the analysis is divided into two stages. In the first stage the gas expands as a spherical bubble, but the influence of the duct wall is taken into account. At the end of the first stage the spherical shape of the bubble is assumed to be lost and the gas is assumed to expand axially as a column. The analysis involves solving the continuity and momentum equations for the liquid along with the energy balance equation for the gas.

49927 (INIS-mf—4498, pp v) **Structural analysis of subassembly wrapper tubes with the three-dimensional finite element code KASTEN.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The code KASTEN subdivides a tube in up to 30 axial rings of hexagonal (wrapper) or circular (clad) cross section. Each ring consists of 6 trapezoidal (wrapper) or 80° ring sector (clad) plate elements. Compared to the analytical integration a parametric study shows that a low order numerical integration of the element matrices is sufficient. The resulting linear equation for the displacements of the corner points is solved by a modified Gauss' Algorithm which uses the sparsity of the stiffness matrix for saving central store capacity. By these means the codes requires only 60 K Bytes central store. The code calculates the thermal and neutron swelling strains and the resulting displacements and stresses. The creep strains are calculated iteratively for each time step. External forces induced by pressure, fixed or flexible supports are taken into account and may be changed during the irradiation time. The code has been used to investigate the behavior of pins and wrapper tube in the planned KNK-II carbide element under various loading conditions and with different swelling formulas. The main outcome of the calculations are: 1) The inherent uncertainly of the swelling formulas lead to very different results for the upper and lower boundary of the swelling formula. 2) In wrapper tubes of cold worked materials which show high swelling at low temperatures the temperature and swelling induced bowing moments interfere in that way that the end deflections are constant or even decreasing with time if the wrapper tube is clamped below and above the core.

49928 (INIS-mf—4498, pp v) **Analysis of bowed reactor cores using the FIAT-program.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

FIAT is based on the NUBOW code of ANL. FIAT calculates the force equilibrium configuration of elements in a spoke, treating the ducts as beam members. The iteration technique, which is taken from NUBOW, is used in FIAT to calculate the gap distribution between the pads of the elements in the considered spoke. Knowing the gap distribution a direct solution of the unknown mechanical displacements and forces in the load planes can be given. As the gap distribution hardly changes during the burn-up history, the use of the iteration part is not required very often. The computer running times of the combined method are about 10 times less than the strict iteration technique as used in NUBOW. The computer running time reduction is improving with increasing numbers of load planes between the elements. Other improvements of FIAT over NUBOW are bowing of elements due to neutron induced swelling and creep effects, and the growth of duct width due to pressure drop and creep (bulging). In small time steps (approximately 4d) the additional amounts of swell bowing, creep bowing and growth of duct width are calculated. The equilibrium configuration is calculated after every time step to minimize the error produced by calculating at discrete time points. The calculation of the bowing reactivity of a burned core can be performed for any desired time in reactor history. The shut-down situation (low temperature level, no temperature gradients but bowed elements due to neutron fluence) can also be calculated at any time. At these time points a management of fuel elements can be prescribed, e.g. insertion of fresh elements or reshuffling of burned elements. With FIAT, the mechanical configuration of a reactor core can be calculated for the whole reactor history.

49929 (KFK—2589) **Neutron noise analysis for malfunction diagnosis at sodium cooled reactors.** Hoppe, P. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter; Karlsruhe Univ. (TH) (Germany, F.R.). Fakultaet fuer Maschinenbau). Sep 1978. 145p. (In German). U 08/MF A01.

Thesis.

For the investigation of the potential use of neutron noise analysis at sodium cooled power reactors, measurements have been performed at the KNK I reactor over a period of 18 month under different operational conditions. The signal fluctuations of the following tranducers have been recorded: In-core and Ex-core neutron detectors, temperature-, flow-, pressure-, vibration- and acoustic sensors. These extensive measurements have been analyzed in the frequency range from 0,001 Hz to 1000 Hz with all currently known methods for the identification of noise sources. The following results have been found: - Neutron noise for $f<1$ Hz is due to reactivity fluctuations only, for $f>20$ Hz the white detection noise prevails. In the region from 1 Hz to 20 Hz the vibrations of core components contribute to neutron noise. - Neutron noise is influenced by the state of the plant. - The contributions to neutron noise due to the fluctuations of coolant flow and inlet temperature are small compared to those produced by the movements of the control rod initiated by the reactor control system. The quantitatively unidentifiable amount of reactivity fluctuations (0,6 time-dependent thermal bowing of the core. With respect to these results and by calculation of the neutron noise patterns to be expected for the SNR 300, the following possible applications for neutron noise analysis have been found: By means of neutron noise analysis only reactivity fluctuations can be identified and supervised which are produced by time dependent changes of the core geometry. Furthermore neutron noise analysis is well suited for a sensitive detection of control rod vibrations and of local sodium boiling. Finally it can be used for the surveillance of the proper functioning of the reactor control system and of the control rod drive mechanism. (orig./HP) 891 HP.

49930 (KFK—2668) **Analysis of sodium-void experiments in ZPPR-3 modified Phase 3 core.** Yoshida, T. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Aug 1978. 45p. U 03/MF A01.

Work performed under United States—W. Germany Fast Reactor Exchange Program.

An analysis is presented of a series of sodium-void reactivity measurements performed in assembly 3 of Zero Power Plutonium Reactor (ZPPR-3), a mockup of the US Demoplant. In this series, large-zone sodium-void effects were studied in detail in the presence of many singularities, namely, control rods (CRs) and control rod positions (CRPs). The Karlsruhe data-and-method have been applied to an analysis of these experiments, and the results are presented. The work is aimed at complementing the sodium-void reactivity analysis based on the SNEAK experiments, where it was difficult to simulate a large plutonium-core of a prototype fast breeder reactor.

49931 (NIIAR-P—3(297)) **Radial and axial transfer of fuel in fuel elements with vibrocompacted oxide fuel pins during initial stage of irradiation.** Lebedev, I.G.; Golovnin, I.S.; Kuz'min, V.I.; Bibilashvili, Yu.K.; Kalashnik, G.V.; Piskun, A.S.; Matveev, N.P.; Mal'kevich, B.V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 25p. (In Russian). U 03/MF A01.

There are described the results of the radial and axial redistribution of the fuel in the experimental fuel elements with the vibropacked powder oxide fuel in the fast power reactors. Irradiation has been accomplished in reactors SM-2 and BR-5 at a linear power of 300-650 W/cm. The average density of the core has been changed within 8-9 g/cm^3. Besides, the loading conditions, thermal stress and power operating time have been varied. It is established that with the increase of the linear power from 300 to 600 W/cm at an average loading rate of $>= 80$ W/(cmxh) the axial transfer of the fuel owing to leakage of the melt increases by 20%. At a linear power of about 500 W/cm, the mass transfer decreases down to 6%, with the increase of the core density up to 9 g/cm^3. It is shown that at the temperature in the centre of >2600 deg C the axial transfer of the fuel via the steam phase may reach $>= 5\%$. The thermal-physical characteristics of the vibro-packed oxide fuel which have been determined experimentally, as well as the mass transfer data, make it possible to draw a conclusion that the optimum density of the fuel amounts to 9-9.5 g/cm^3.

49932 (NIIAR-P—9(303)) **Fast-response polar correlometer.** Aleksandrov, K.A.; Verkhusha, V.G.; Golushko, V.V.; Panina, I.V.

(Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 11p. (In Russian). U 02/MF A01.

In the reactor researches devoted to localization of the sodium coolant boiling point, there are widely employed the acoustic methods based on measurement of the delay time of the signals arriving at the transducers from the noise source. Measurement of the delay time by calculation of the polar mutual correlation functions provides for determination of the noise source coordinates. There has been developed a high-speed polar correlatometer for investigation of the sodium coolant boiling signals within a range of 1-200 kHz, which provides for calculation of 128 ordinates of the polar mutual correlation function, 32 ordinates being calculated at a time. The delay time ranges from $128x10^{-6}$ to $128x10^{-3}$ s. The maximum frequency of process quantization amounts to 1 MHz. One channel is rated for 15 binary digits and one sign digit. The instrument employs the integral circuits. High speed of the instrument is obtained due to series-parallel calculation of the correlation function ordinates.

49933 (SAN—1011-200) **Test verification of seismic response of LMFBR piping systems. Quarterly technical progress report.** (Agbabian Associates, El Segundo, CA (USA)). Jan 1979. Contract EY-76-C-03-1011. 96p. AT.

The objective of this investigation is to experimentally verify the analytically predicted dynamic response of a typical breeder reactor piping system to the design seismic input motions. This is a progress report on the first phase of a two-phase investigation. The objective of the first phase is to develop a test plan which would include the selection of the system to be tested, definition of the analytical and experimental studies to be performed, and the preparation of a cost estimate for the second phase. The second phase of the investigation is to provide the tests and supporting analyses. This report summarizes work performed through October 1978. Work performed consists of a background review, definition of a typical breeder reactor piping system and studies to define the problems associated with both the analytical and experimental portions of the verification program.

49934 (WAPD-TM—1368) **Nondestructive assay of UO_2—ThO_2 fuel pellets using the delayed neutron pellet assay gage (LWBR Development Program).** Emert, C.J.; Milani, S.; Beggs, W.J. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Jun 1979. Contract EY-76-C-11-0014. 45p. P 03/MF A01.

This report describes the use of a delayed neutron pellet assay gage to determine nondestructively the fissile content of fuel pellets during the manufacture of the Light Water Breeder Reactor (LWBR) core. The gage characteristics are described including the nature of the calibration curves and the gage sensitivities to pellet parameters. Statistical methods are derived for analyzing the data to obtain the mean weight percent of total uranium in each blend of fuel material as well as the loading precision of each fuel rod. The fissile loading of each fuel rod was determined to better than 0.25% at the 2 σ level, and the fissile content of eight fuel compositions in the LWBR core was obtained to better than 0.1%. Use of this gage and the data analysis methods described in this report reduced the need for destructive chemical analysis of fuel pellets by a factor of two.

49935 (WAPD-TM—1404) **Ex-reactor deformation of externally pressurized short lengths of fuel rod cladding. LWBR development program.** Selsley, I.A. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). May 1979. Contract EY-76-C-11-0014. 80p. P 05/MF A01.

The DECAG (Deformation of Cladding into Axial Gaps) ex-reactor test program evaluated deformation of Zircaloy-4 cladding into axial gaps in tubular fuel elements. These axial gaps are the result of cladding elongation and fuel stack shrinkage. The test program consisted of twelve series and subseries of both fully recrystallized and stress-relieved highly cold worked tubing tested under pressure-temperature combinations in autoclaves. The test program also verified the validity of achieving test acceleration through the use of elevated temperatures by correlating both ovality and diameter change at lower temperatures with the Larson—Miller Parameter.

49936 (WAPD-TM—1449) **Integral testing of thorium and U233 data for thermal reactors (AWBA development program).** Hardy, J. Jr.; Ullo, J.J.; Steen, N.M. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Jun 1979. Contract EY-76-C-11-0014. 133p. P 07/MF A01.

A survey is made of integral experiments useful for testing thorium and ^{233}U nuclear data in thermal reactor applications. Emphasis is on homogeneous ^{233}U—H_2O criticals and simple, water-moderated ^{233}U—thorium and ^{235}U—thorium lattice experiments. Thorium—^{233}U-graphite experiments are also discussed briefly. Although the available experiments provide a fairly consistent test of important nuclear data, their accuracy and scope leave much to be desired. In detailed Monte Carlo analyses, ENDF/B-IV data are found to perform reasonably well. Adequate (though partly fortuitous) agreement is found with integral measurements of thorium resonance capture in lattices. A new, harder fission spectrum for ^{233}U can correct the principal discrepancy observed with ENDF/B-IV, a bias trend in K/sub eff/ attributed to an underprediction of leakage.

49937 (WARD-CR—3045-24) **Core restraint development. Quarterly progress report for period ending August 31, 1978.** Mangus, J.D. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1979. Contract EY-76-C-02-3045-005. 159p. AT.

Progress is summarized in the following areas: core mechanics and configuration performance; seven-row test evaluations; fourteen row testing; withdrawal/refueling test plan; FFTF load pad dimensional analysis; assessment of proposed Revision 4 creep and Revision 6(7) swelling equations; benchmark problem set for core restraint evaluation of irradiation creep and swelling equations; EBR-2 reflector assembly bowing assessment; swelling-irradiation creep opposition test; FFTF benchmark experiment technical feasibility assessment; TRITON development and verification; ANSYS and CRAMP friction effects evaluations; and national core mechanics and configuration performance plan.

49938 (WARD-OX—3045-46) **Examination and performance evaluation of WSA-3 grid-spaced mixed-oxide fuel pins.** Nayak, U.P.; Levine, P.J.; Roth, T.S. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1979. Contract EY-76-C-02-3045-007. 169p. AT.

The WSA-3 subassembly was designed to evaluate the performance of mixed-oxide fuel pins in a grid-type spacer system in EBR-II. The design of the fuel pins was directed to evaluate the effects of design and operating parameters, particularly the sensitivity of cladding deformation to these parameters. Following successful operation to the goal burnups (12.5% peak) and fast fluence ($\sim 8 \times 10^{22}$ n/cm^2) at $\sim$ 30 kW/m with peak cladding midwall temperatures of $\sim$ 560°C the 37 pins were nondestructively examined and 8 pins were subjected to destructive examination. The results of the examination showed that the grid-spacer system is a viable alternative to the wire-wrap spacer system. The fuel pin data provided significant information on the sensitivity of cladding deformation to pellet density, gap size, smear density and burnup.

49939 (WARD-RB—3045-31) **Radial blanket design and development. Quarterly progress report for period ending November 30, 1978.** Bishop, E.C. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1979. Contract EY-76-C-02-3045-004. 80p. AT.

Information is presented concerning the radial blanket assembly heat transfer test; radial blanket assembly irradiation; radial blanket flow orificing; and radial blanket rod bundle compaction tests.

49940 (WARD-XS—3045-24) **Physics evaluations and applications quarterly progress report for period ending October 31, 1978.** Yarbrough, M.B.; Calamai, G.J. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Mar 1979. Contract EY-76-C-02-3045-012. 39p. AT.

During this quarter, Westinghouse further quantified the disc usage charge components during the VENTURE analysis of the large 84 x 42 x 33 mesh, 9 group test problem. Previous work with the large test problem had shown that $\sim$ 45% of the total job cost was attributable to storing and retrieving information from disc. Westinghouse therefore studied this problem in a three-step analysis program. First, a parametric study was performed to determine the impact of varying the disc file allocation and transfer size parameters, via the CDC-7600 job control language specifications. Second, the data transfers themselves were monitored during the flux solution iterations to identify the key cost components. Finally, the results of the two previous steps were combined to identify areas where modifications to the data transfer strategy may be beneficial to utilization of the code at Westinghouse.

49941 **Maintenance assessment for advanced nuclear power plants.** Basham, S.J. Jr.; Waddell, J.D.; Robinson, R.A.; Kok, K.D. (Battelle Mem Inst, Columbus Lab, Ohio). *Am. Soc. Mech. Eng., [Pap.]*; No. 78-WA/NE-1, 1-7(Dec 1978).

Proper planning for maintenance and inspection tends to increase the overall availability of nuclear power plants. High potential availability is the basic measure of a successful power plant since replacement power costs are high. The study reported here compared the maintenance and inspection requirements of generic pool and loop type Liquid Metal Fast Breeder Reactors to determine if there were significant differences in these two systems owing to their fundamental difference in design. The size, number and types of failed components affected downtime for maintenance but accessibility and arrangement of components also strongly influenced the downtime. 10 refs.

49942 (DOE-tr—61) **Direct numerical simulation of turbulent velocity, pressure, and temperature fields in channel flows.** Groetzbach, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany,

F.R.). Inst. fuer Reaktorentwicklung). 15 Sep 1978. Translation of KFK—2426, October 1977. 217p. U 10/MF A01.

Work performed under United States—W. Germany Fast Reactor Exchange Program.

For the simulation of nonsteady, three-dimensional, turbulent flow- and temperature-fields in channel flows of fluids with constant properties a method is presented which is based on a finite difference scheme of the complete conservation equations for mass, momentum, and enthalpy. The fluxes of momentum and heat within the grid cells are described by subgrid scale models. The subgrid scale model for momentum introduced here is for the first time applicable to small Reynolds numbers, rather coarse grids, and channels with space-dependent roughness distributions. The new developed subgrid scale model for temperature also takes the influence of the molecular Prandtl number into consideration. For Prandtl numbers of about one, the theoretical model confirms the empirically derived values for the turbulent subgrid scale Prandtl number, which are currently used by other authors. For very small molecular Prandtl numbers of liquid metals, the model shows that the total resolution of all relevant temperature fluctuations can be achieved on the basis of presently realizable grids. The method is realized in the computer code TURBIT-2. It can be used for the simulation of laminar flows in plane channels and annuli as well as for turbulent flows with Reynolds numbers larger than about 10^4. The numerical results for the flow field show only a small influence of the model parameters. For smooth, rough, and partly roughened channels with secondary flows the agreement with experimental results is fairly good even when rather coarse grids are used. The temperature fields simulated are very insensitive to the parameters of the model. The numerical results are in good agreement with consistent, reliable experimental results.

49943 Pressure transient analysis in single and two-phase water by finite difference methods. Berry, G.F.; Daley, J.G. (Argonne National Lab., IL (USA)). pp 1-12 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

An important consideration in the design of LMFBR steam generators is the possibility of leakage from a steam generator water tube. The ensuing sodium/water reaction will be largely controlled by the amount of water available at the leak site, thus analysis methods treating this event must have the capability of accurately modeling pressure transients through all states of water occurring in a steam generator, whether single or two-phase. The equation systems of the present model consist of the conservation equations together with an equation of state for one-dimensional homogeneous flow. These equations are then solved using finite difference technique with phase considerations and non-equilibrium effects being treated through the equation of state. Fluid-structure interactions were not included at the time of this writing but are treated in the systems code which will contain this water-side transient model.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 50050, 50074

49944 (BNL—50831-6) **Design guide for category VI reactors: air-cooled graphite reactors.** Brynda, W.J.; Karol, R.; Powell, R.W. (Brookhaven National Lab., Upton, NY (USA)). Feb 1979. Contract EY-76-C-02-0016. 188p. P 09/MF A01.

The purpose of this Design Guide is to provide additional guidance to aid the DOE facility contractor in meeting the requirement that the siting, design, construction, modification, operation, maintenance, and decommissioning of DOE-owned air-cooled graphite reactors be in accordance with generally uniform standards, guides, and codes which are comparable to those applied to similar reactors licensed by the Nuclear Regulatory Commission (NRC).

49945 (DOE/EIA—0184/11) **Evaluation of potential short-term nuclear availability levels and associated electric utility alternate fuel-use responses.** Clark, G.; Gielecki, M.; Roberts, B. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jul 1979. 47p. P 03/MF A01.

Short-term projections of nuclear power availability associated with various legislative and regulatory proposals that have been or are being considered are discussed. Projections of electric utility alternate fuel use and fuel expenditures associated with the levels of projected nuclear availability are also presented. Four proposed initiatives are analyzed with respect to their effects on nuclear power generation and electric utility alternate fuel use for the years 1979 and 1980. The cases analyzed assume business-as-usual, including the 3-month moratorium on all new nuclear plant licenses announced by the NRC in May 1979; that the NRC will require all nuclear pressurized water reactors to shut down for a 4-month period sometime prior to the end of 1980 in order to institute potential instrumentation and control room improvements resulting from the Three Mile Island accident investigation; assume that no nuclear operating licenses will be granted by the NRC until the state in which the applicant's plant is located has had its state emergency response plan approved; and assume that operating nuclear power plants in states without NRC-approved emergency response plans must be removed from service after April 1, 1980.

49946 (RDT-INDEX—(7-79)) **RDT Standards index: July 1979.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 19 Jul 1979. Contract W-7405-ENG-26. 38p. RSO.

The July 1979 Index of RDT Standards for the period April through June 1979 is presented.

49947 (RDT-STATUS—(7-79)) **RDT Standards status report: July 1979.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 19 Jul 1979. Contract W-7405-ENG-26. 39p. RSO.

The July 1979 Status Report of RDT Standards covering the period of April through June 1979 is presented.

49948 (SAN—2055-T1) **Review of nuclear power reactor decommissioning alternatives.** (Bechtel National, Inc., San Francisco, CA (USA)). Oct 1978. Contract ER-78-C-03-2055. 67p. P 04/MF A01.

The aim of this study was to assess the validity of the AIF/NESP decommissioning study without introducing a new estimate with a new set of assumptions and bases. The approach taken in this assessment was to review the assumptions regarding the regulations applicable to the decommissioning effort and then to evaluate the alternatives proposed. The methodology and procedures employed were evaluated to assess their feasibility based on experience in the design and construction of nuclear power plants. Finally the cost estimates were analyzed without preparing a new detailed estimate. These reviews were then used to evaluate the overall acceptability of the AIF/NESP report as a basis for individual plant estimates and to identify those areas that appear to require additional support or further investigation.

ECONOMICS

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 49882

FUEL CYCLE

49949 (GEFR—00392) **Preconceptual design study of proliferation-resistant homogeneous oxide LMFBR cores.** Talwar, B. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Nov 1978. Contract EY-76-C-03-0893-031. 265p. AT.

The preconceptual design and performance of four 1000 MW(e) homogeneous oxide LMFBR cores are described. Ge-ARSD developed the core designs as part of the Proliferation Resistance LMFBR Core Design Study (PRLCDS). The first design is the reference, using $(PuU)O_2$ fuel in the core and UO_2 in the axial and radial blankets. The second design is identical to the first, except that ThO_2 replaces UO_2 in the blankets. The third design is optimized for the use of $(PuTh)O_2$ in the core and ThO_2 in the blankets. Both of the second and third reactors produce the fissile isotope ^{233}U and are referred to as transmuters. Either transmuter can form a symbiotic reactor system with the fourth reactor, which uses proliferation-resistant denatured $(^{233}U—^{238}U)O_2$ fuel with a fissile enrichment below 12%. The blankets of the denatured reactor contain ThO_2. All the designs were developed under a uniform set of ground rules. The performance evaluations consist of nuclear, thermal/hydraulic, mechanical, resource utilization, and preliminary safety evaluations. The PRLCDS thermal/hydraulic and mechanical performance cross-cutting study is also included.

PROCESS HEAT REACTORS

49950 (GA-A—15405) **HTGR process heat program design and analysis. Semiannual progress report, October 1, 1978—March 31, 1979.** (General Atomic Co., San Diego, CA (USA)). Jul 1979. Contract EY-76-C-03-0167-061. 78p. P 05/MF A01.

This report summarizes the semiannual FY-79 results of the concept design studies at General Atomic Company (GA) for an 842-MW(t) VHTR utilizing an intermediate helium heat transfer loop to provide thermal energy for the production of reducing gas (H_2 + CO) by steam-reforming of a light hydrocarbon. Basic carbon sources may be coal, residual oil, or oil shale. The report summarizes the conceptual design tasks conducted on the intermediate heat exchanger, reformer, and steam generator. The status of performance/optimization code development and the safety evaluation stud-

ies presently under way are reported. The completion of the milestones concerning the Plant Technical Description and the VHTR balance of plant cost is also reported.

49951 (INIS-mf—4376, pp 132-142) **Measures to ensure the possibility of future heat supply from the Kaiseraugst Nuclear Power Station.** Fazekas, J.; Mamuzic, M. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). 1977.

From Meeting on low temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The present paper demonstrates which measures need to be taken in such a case when the utilization of nuclear heat is envisaged, but will become possible only many years after the construction of a nuclear power plant, in this case the Kaiseraugst reactor on the border of Switzerland and Germany. It has been shown that it is reasonable to assure the future possibility of long distance heat supply from the reactor. The necessary preliminary investment for this nuclear station presently being built is small as compared with the plants total investment.

49952 (Juel—1516) **Supply of heat, electricity and synthesis gas for conurbations by means of a nuclear energy transport system demonstrated by the example of Cologne and its environs.** von Loiewski, D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung; Technische Hochschule Aachen (Germany, F.R.)). Jun 1978. 99p. (In German). U 06/MF A01.

Thesis.

The practical example of the Greater Cologne area is taken as a basis for demonstrating the fact that a nuclear energy transport system is able to contribute considerably to the coverage of energy needs of conurbations. For this purpose, those fractions in the energy demand of the Greater Cologne area, which can be covered by the output of the system involved, were investigated and extrapolated with a view to the earliest possible date of operation in the year 2000. The study also accounted for a substantial synthesis gas supply from an integrated coal gasification plant. The annual and daily characteristic of requirements was determined for the system in the light of the calculated market potentials allowing for the operation of three high-temperature reactors of 3000 MWth each. The technical details of the system were designed on the basis of these calculations. Taking into account any envisaged outage periods of the reactors and the storage possibilities of the system products, the load factor and the utilization rate of the system were calculated. It is demonstrated that also with a view to economic aspects it is not only possible but also advantageous to have the demand of district heat peaks covered by the system in question.

NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 49864

THEORY AND CALCULATION

49953 (FEI—737) **Algorithm of the solution for a two-dimensional reactor equation in the two-group diffusion approximation.** Buleev, N.I.; Ginkin, V.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 13p. (In Russian). U 02/MF A01.

An algorithm for calculating a reactor in the two-group diffusion approximation in (x,y)- and (r,z)-geometries is described. The difference equations satisfying the balance relationship are derived using the integral method. In order to find a solution of the five-point equations the internal iterative method is used that is a sort of the pertial factorization scheme. The scheme employed ensures a high convergence rate of the iterative process. The "FACTOR" computer code is written in the FORTRAN language for the ES-1030 computer and employs only the operative memory.

49954 (IAE—2550) **Measurement of neutron characteristics of a cavity assembly with an outer light water moderator.** Chuvilin, D.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 14p. (In Russian). U 02/MF A01.

The neutron spatial distribution in the volume of a model of a gaseous cavity reactor was measured. Some integral characteristics of the neutron energy spectrum were determined. The comparison of the calculate europium spectrum index by the P_3-approximation with the measured europium spectrum index was conducted. The neutron multiplication factor of the nuclear reactor model was calculated from the measured neutron spatial distribution.

49955 (IAE—2793) **Homogenization of the effective cross sections in a periodic lattice.** Sidorenko, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 35p. (In Russian). U 03/MF A01.

A method of obtaining homogenized neutron cross sections for periodic reactor lattices in the P-1 approximation is described. Some general properties of the neutron distribution in an infinite lattice which do not depend on its specific structure are obtained using conditions of lattice periodicity and symmetry. E xpressions for the neutron distribution in a finite medium much larger than a separate cell are formulated. In this case the homogenized cross sections have proved to depend only on the neutron distribution in an equivalent cell. For the thermal energy range a description is given of the method developed to account for the simultaneously heterogeneous and thermalization effects on the homogenized diffusion coefficient.

49956 (IAE—2807) **Neutron diffusion in heterogeneous media ("source-sink" method).** Laletin, N.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 15p. (In Russian). U 02/MF A01.

The neutron diffusion equations are derived from a kinetic equation written in the two-group approximation. The "source-sink" method is employed. The validity frames of the approximations are discussed as well as merits and demerits of the obtained equations set from the point of their numerical solution on computers.

49957 (IAE—2808) **Derivation of the "source-sink" technique equations from the kinetic equation.** Laletin, N.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 15p. (In Russian). U 02/MF A01.

The "source-sink" technique equations are derived from the the Boltzmann equation with a continuous energy dependence. The media is assumed to represent a uniform moderator where there are blocks (channels) with different fissioning, absorbing and moderating properties. The blocks are infinite cylinders with parallel axes. The set of equations is obtained in a two-group approximation with the account of neutron moderation,, resonance absorption and multiplication in a block.

49958 (IAE—2891) **Accuracy of the quasialbedo method.** Gomin, V.A.; Gorodkov, S.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 11p. (In Russian). U 02/MF A01.

The Galanin-Feinberg equations usually applied in the calculations of neutron fields in the heterogeneous reactors may be rewritten with a high accuracy in the form similar to the finite difference equations. This was achieved previously with the help of the so-called quasialbedo method. The finite-difference scheme developed was of 9 point type. The 25 point scheme is developed, which is much better approximated to the basic equations. Computer code, based on this new scheme, may be used for testing some doubtful result of previous programs. In the comparative calculations of a heterogeneous assembly the 9 point scheme achieved the 0.02% accuracy in Ksub(ef) and 0.05% - in fluxes.

49959 (IAEA—213(Vol.1), pp 61-89) **Importance of fission product nuclear data in reactor design and operation.** Devillers, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1978.

From Meeting on fission product nuclear data; Petten, Netherlands (5 Sep 1977).

This paper is devoted to the updating of nuclear data requirements concerning fission products in the three application fields of contamination of reactor components, detection of fuel failures and decay heat. It is concluded that almost all requirements related to contamination and fuel failure detection are met. For decay heat following a long irradiation time, nuclear data requirements are supported by sensitivity analysis for the five top priority cases of ^{233}U, ^{235}U, ^{239}Pu thermal fission and ^{235}U, ^{239}Pu fast fission. From error estimates associated with decay heat summation calculations, contributions to the total error come, in decreasing order, from uncertainties in effective decay energies (E vector sub(β) + E vector sub(γ)), yields (independent yields for cooling times $< 10^4$ s, chain yields beyond) and half-lives of individual isotopes. Comparisons made between predictions and calorimetric measurements as well as between different summation calculations seem to confirm theoretical error estimates. Further work in evaluating error bars in decay energies and yields of contributing isotopes is however necessary.

49960 (IAEA—213(Vol.1), pp 41-60) **Needs and accuracy requirements for fission product nuclear data in the physics design of power reactor cores.** Rowlands, J.L. (UKAEA, Winfrith. Atomic Energy Establishment). 1978.

From Meeting on fission product nuclear data; Petten, Netherlands (5 Sep 1977).

The fission product nuclear data accuracy requirements for fast and thermal reactor core performance predictions were reviewed by Tyror at the Bologna FPND Meeting. The status of the data was assessed at the Meeting and it was concluded that the requirements of thermal reactors were largely met, and the yield data requirements of fast reactors, but not the cross section requirements, were met. However, the World Request List for Nuclear Data (WRENDA) contains a number of requests for fission product capture cross sections in the energy range of interest for thermal reactors. Recent reports indicate that the fast reactor reactivity requirements might have been met by integral measurements made in zero power critical assemblies. However, there are requests for the differential cross sections of the individual isotopes to be determined in addition to the integral data requirements. The fast reactor requirements are reviewed, taking into account some more recent studies of the effects of fission products. The sodium void reactivity effect depends on the fission product cross sections in a different way to the fission product reactivity effect in a normal core. This requirement might call for different types of measurement. There is currently an interest in high burnup fuel cycles and alternative fuel cycles. These might require more accurate fission product data, data for individual isotopes and data for capture products. Recent calculations of the time dependence of fission product reactivity effects show that this is dependent upon the data set used and there are significant uncertainties. Some recent thermal reactor studies on approximations in the treatment of decay chains and the importance of xenon and samarium poisoning are also summarized.

49961 (INIS-mf—4498, pp v) **Elastic fuel rod deflections and spacer reactions due to transverse temperature gradients.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Transverse temperature gradients can occur in fuel rods due to power tilts or to thermal-hydraulic variations in the coolant subchannels which surround the fuel rod. Evaluations of the fuel rod deformations and spacer reaction forces associated with thermal gradients occurring during long term power operation involve complex computer analyses which include creep relaxation effects. During certain transient or accident situations even more severe short term thermal gradients can be developed due to subchannel power-to-flow imbalances wherein the associated elastic fuel rod deformations and spacer reaction forces are of interest both from a structural and a thermal-hydraulic feedback point of view. This paper evaluates the elastic fuel rod lateral deflections and the spacer reaction forces for a fuel rod subjected to a uniform lateral temperature gradient along its entire length. Dimensionless displacement and force functions were evaluated using simple beam formulas and superposition principals and are presented for from two to seven equal pitched spacers (or conversely, for one to six spans).

49962 (ITEF—68(1978)) **Numerical method of optimizing spatial characteristics of heterogeneous reactors.** Malofeev, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1978. 21p. (In Russian). U 03/MF A01.

A numerical method of optimizing spatial characteristics of a reactor is developed on the basis of the heterogeneous reactor difference equations. Formulae of the perturbation theory and corresponding conjugate equations are obtained in the form convenient for practical use. An iterative method to solve the equations, that is based on the Chebyschev technique of accelerating convergence is proposed. The algorythm is put into practice in the MARC code (FORTRAN, BESM-6 computer).

49963 (JAERI—1255) **JAERI Fast Reactor Group Constants Set, version 2.** Takano, H.; Hasegawa, A.; Nakagawa, M.; Ishiguro, Y.; Katsuragi, S. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 206p. U 10/MF A01.

The JAERI-Fast set version II(JFS-V-II) has been produced by revising the original JAERI-Fast set on a large scale. The revision works have been performed on the basis of the benchmark calculation for many fast critical assemblies, the cross section adjustment of using the least squares method and the evaluation of nuclear data. In JFS-V-II, the group constants of 25 nuclides, Be, ^{10}B, ^{11}B, C, O, Na, Al, Si, Cr, Mn, Fe, Ni, Cu, Mo, ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu and ^{241}Am and FP group constants have been provided for both the standard seventy and twenty-five group structures. The composition dependence of group constants is taken into account for all these nuclides by preparing self-shielding factors. Especially, the self-shielding factors of important resonant nuclides are expressed by a function of three variables, i.e., composition, temperature and mutual interference parameter which is the ratio of the atomic number density of ^{238}U to that of the fissile resonant nuclei. Moreover, the infinitely dilute elastic removal cross sections and self-shielding factors of the elastic removal cross sections are newly tabulatcd for important light and medium nuclides, O, Na, Fe, Cr, Ni and Al. Applicability of JFS-V-II was assessed through the benchmark tests for many fast critical assemblies and the results were summarized.

49964 (KFK—2585) **NOASYS, a system for on-line noise analysis.** Massier, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Jul 1978. 57p. (In German). U 04/MF A01.

This report describes NOASYS, a versatile NOise Analysis SYStem for digital on-line signal processing. The system based on a minicomputer, was originally developed for the analysis of noise signals from nuclear reactors. NOASYS computes various statistical functions e.g. cross- und auto-correlation functions and power spectral densities resp., which may be used for reactor diagnosis and malfunction detection. The system processes up to 16 analog signals with a maximum sampling frequency of 100 kcps (1 channel). The processing of the sampled data is done by a number of software tasks, which may be called from a teletype or linked together for specific measuring programs. The standard configuration contains the often used processing routines e.g. Fast Fourier Transform, complex multiplication, summation etc. In addition NOASYS may be extended by users own tasks (in Assembler or Fortran) to fit for specific applications. (orig.) 891 HP.

49965 (NUREG/CR—0823) **Buckled spherical harmonics solutions of neutron transport problems.** Blomquist, R.N.; Lewis, E.E. (Northwestern Univ., Evanston, IL (USA). Technological Inst.). Apr 1979. 103p. Q 06/MF A01.

The within-group even-parity neutron transport equation is formulated with complex angular and spatial trial functions and with a complex buckling approximation. Three angular trial functions are compared; finite elements, discrete ordinates, and complex spherical harmonics. When discrete ordinates or finite element basis functions are applied, the differential equations for the real and imaginary parts of the even-parity flux are coupled by the buckling vector. The spherical harmonics equations for the real and imaginary parts of the even-parity flux, however, uncouple when one particular transverse buckling direction is chosen for a two-dimensional problem. Bilinear rectangular finite elements are applied to the spatial variable, the buckled spherical harmonics angular treatment is generalized to arbitrary order, and the resulting formulation is incorporated into a multigroup formalism using a lumped source approximation. The finite element/buckled spherical harmonics multigroup neutron transport code, FESH, has been developed from these approximations, and treats either fixed source problems or criticality eigenvalue problems. The applicability of this method to problems with several thousand spatial nodes has been demonstrated by comparison of numerical results with another spherical harmonics code and with other computational methods. Buckled two-dimensional eigenvalue calculations reveal substantial improvements over the DB^2 buckling method when transverse transport effects are important.

49966 (ORNL/TM—6843) **Iterative behavior of diffusion theory flux eigenvalue neutronics problems.** Vondy, D.R.; Fowler, T.B. (Oak Ridge National Lab., TN (USA)). May 1979. Contract W-7405-ENG-26. 39p. P 03/MF A01.

Information is presented about the iterative behavior of selected reactor neutronics problems applying the finite-difference diffusion theory approximation to neutron transport. Several problems were solved different ways to examine the effects of variations in the iteration procedures on the rate of convergence. Estimates of dominant error vector eigenvalues and their dependence on the inner iteration procedures are shown. This information is important because it serves as a guide for code development and application, lacking a thorough theoretical analysis of the iterative behavior.

49967 **Dynamic analysis of structure with solid-fluid interaction.** Nahavandi, A.N. (Newark Coll. of Engineering, NJ (USA)); Pedrido, R.R. (Bell Telephone Labs., Inc., Holmdel, NJ (USA)); Cloud, R.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Energy Systems Div.). pp 1-14 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Interaction between solid and fluid has been recognized to be an important factor for the study of flow-induced vibration in nuclear reactor components. This study develops a finite element method model for interaction between an elastic solid and a fluid medium. Plane triangular finite elements have been used separately for fluid, solid, and solid-fluid continuua and the equivalent mass, damping, and stiffness matrices and interaction load arrays for all elements are derived and assembled into global matrices. The global matrix differential equation of motion developed is solved in time to obtain the pressure and velocity distributions in the fluid as well as the displacements in the solid. Two independent computer programs, each employing different algorithms and numerical solution techniques are used to obtain the dynamic solution. The first program is a special purpose finite element program developed by the authors.

for solid-fluid interaction studies. The second program is WECAN (Westinghouse Electric Computer Analysis), a general purpose finite element program in which a new element library subroutine for solid-fluid interaction was incorporated. Results have been obtained for the case of water, between two flat elastic parallel plates, initially at rest and accelerated suddenly by applying a step pressure. The results obtained from the above-mentioned two independent finite element programs are in full agreement.

49968 Efficient formulation of the finite element method for heat conduction in solids. Sandsmark, N. (Det Norske, Veritasveien, Hoevik, Norway); Medonos, S. (A.S. Computas, Brick Close, Kiln Farm, Milton Keynes, United Kingdom); Aamodt, B. (Det Norske Veritas, Veritasveien, Hoevick (Norway). Engineering Department). pp 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of the paper is to describe efficient methods and computer programs for analysis of heat conduction problems related to design and control of components of nuclear power plants and similar structures where thermal problems are of interest. A short presentation of basic equations and the finite element formulation of three-dimensional stationary and transient heat conduction is given. The finite element types that are used are isoparametric hexahedrons with eight or twenty nodes. The use of consistent as well as diagonal capacity matrices is discussed. Reduction of the transient heat conduction problem may be accomplished by means of the 'master-slave' technique. Furthermore, the superelement technique is discussed for both stationary and transient heat conduction. For the solution of transient problems, the trapezoidal time integration scheme is used. The methods and principles outlined in the paper are materialized in a computer program NV615, which is one of the application programs in the program system SESAM-69. A brief description is given of NV615.Furthermore, attention is given to combined heat conduction and subsequent thermal stress analysis. In order to investigate the accuracy and the efficiency of the methods, some heat conduction problems for which analytical solutions are known are analysed- specificilly: a) Semi-infinite solid with specified surface temperature, varying periodically with time. b) Semi-infinite solid with line heat source. Transient analysis. As an example of practical application the temperature distribution versus time in a turbine wheel during start up is analysed. Thermal stresses are calculated at selected time instants.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 50137, 50315, 50317, 50322, 50323, 50324, 50326, 50327, 50328, 50344, 50350, 50364, 50365, 50369, 50370, 50371, 50372, 50373, 50374, 50375, 50394, 50395, 50917

49969 (ANL-CT—79-38) **Wall pressure fluctuations on a cylinder in annular water flow.** Wambsganss, M.W.; Jendrzejczyk, J.A.; Lawrence, W.P. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 73p. AT.

Wall pressure fluctuations beneath a turbulent boundary layer are a primary excitation source for parallel flow induced vibration. Prediction of component response to this excitation requires an understanding of the structure of the pressure field and its mathematical characterization. Measurements of wall-pressure fluctuations on the surface of a cylinder in annular water flow are reported with emphasis on the low-frequency behavior of the pressure field. Pressure differences from diametrically-opposite, surface-mounted pressure transducers are utilized to eliminate farfield (acoustic) noise. Power spectral densities, both broad- and narrow-band, longitudinal space—time correlations, and rms pressure coefficients are computed and reported as an aid to understanding the dynamic behavior of the pressure field. A normalization of the mean-square pressure spectral densities is attempted. In appendices, measurements of the effects of upstream flow spoilers on the intensity and characterization of nearfield flow noise and on the displacement response of a tube in axial flow are reported.

49970 (ANL-CT—79-39) **Determination of turbulent fluid damping by resonant structural testing.** Mulcahy, T.M.; Miskevics, A.J. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 21p. AT.

A theory is developed for determination of velocity squared (turbulent) fluid damping from peak amplitude and phase angle data by complex vector methods. Experimental results are presented indicating the usefulness of the theory, especially in identifying whether velocity squared or viscous damping mechanisms are active.

49971 (INIS-mf—4498, pp v) **Spacers for fuel elements as structural anisotropic plates composed of cylindrical shells.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper the results of investigations concerning the state of stress in the spacers which are assumed to be 'the structural anisotropic plates composed of cylindrical shells' (below: 'plates' only), as well as the behavior of the spacers in the interactions with fuel elements are presented. A method is developed whereby the deformations and stresses in mentioned plates can be computed. A cylindical shell with free ends under various types of unsymetrical radial surface loadings is solved. The obtained equations are used for the solution of the problem which is carried out in matrix form suitable for the numerical solution with the help of a computer. An application of the developed method -including its experimental verification- from the region of spacers for nuclear reactors is shown. The agreement between the theoretical results and experimental ones is reasonably good. Besides nuclear reactor structures the application of the presented method may be found in various branches of industry. The developed method is not limited to one type of boundary edge conditions or to the plates of constant thickness. The method enables the solution of the plates with variable thickness of which boundary edge conditions may be various. The method is also not limited to the type of normal loads. The loads may be arbitrary including aero-hydrodynamic loads. The method makes possible the design of the plates of optimal shape in view of the utilization and minimum use of structural material.

49972 (UCRL—82423) **Reserve seismic capacity determination of a nuclear power plant braced frame with piping.** Nelson, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Feb 1979. Contract W-7405-ENG-48. 11p. (CONF-790802—35). P 02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

A typical diagonal braced steel frame was developed to determine the amount of reserve capacity that is available beyond elastic design levels. The frame was analyzed first using elastic static and dynamic analyses. The loadings included dead and live load, an equivalent static lateral earthquake load, two response spectra and a suite of eight earthquake time history records. The response spectra used were the Housner and Regulatory Guide 1.60. The time histories represented different site conditions, distances to causative faults and magnitudes. The lateral static load and Housner spectrum represent vintage design criteria, while the R.G. 1.60 and time history analyses reflect current methodology. The elastic limit responses of the structure were determined along with the accompanying threshold peak ground accelerations (threshold g values). The frame was then analyzed using the program DRAIN-2D to perform two-dimensional elastic—plastic analyses for the eight time histories.

49973 Influence of axial flow on vibration behaviour of finite cylindrical shells. van Campen, D.H.; Gortemaker, P.C.M.; Weppelink, H. (Technische Hogeschool Twente, Enschede (Netherlands)). pp 1-10 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A computational method is described for calculating the free vibrations of thin finite cylindrical shells with a surrounding fluid gap. The surrounding fluid may have an axial steady velocity. The method can be used as an aid in vibration analysis of thin-walled cylindrical parts of reactor core and coolant circuit structures. The influence axial flow velocity on the free vibrations of a finite cylindrical shell has been studied theoretically and experimentally by Paidoussis and Denise, J. of Sound and Vibrations 20 (1972) No. 1,9-26. The theoretical analysis in this publication relies on a numerical evaluation of the complete infinite series solution of the equation of motion for the shell and implies a considerable amount of difficult iterative work. In the present paper an alternative computational method is described, based on a Rayleigh-Ritz procedure and utilizing a series of beam functions for the radial displacement amplitude of the shell. For an originally motionless fluid, the influence of the coupling effect between the different beam functions is analysed numerically and a comparison is given with experimental evidence. For a fluid with an axial steady velocity, the above computational method is applied to the clamped-clamped and the clamped-free shells analysed by Paidoussis and Denise and a good qualitative agreement could be observed.

49974 Flow-induced instabilities of clusters of flexible cylinders in axial flow contained in a cylindrical channel. Paidoussis, M.P.; Suss, S. (McGill Univ., Montreal, Quebec (Canada). Dept. of Mechanical Engineering). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes a theoretical study of the dynamics of clusters of flexible cylinders in axial flow bounded by a cylindrical rigid pipe, a common geometry in several designs involving liquid-cooled fuel element bundles in pressure tubes. Unlike most previous work where the motions of each cylinder were assumed to be unaffected by motions of adjacent cylinders, in this study both inviscid and viscous coupling in the motions of the cylinders is taken into account, as well as the effect of proximity to the surrounding channel. The inviscid hydrodynamic forces were determined by slender body theory, obtaining the velocity potential at any axial cross-section of the system due to arbitrary small motions of the cylinders. In this way a virtual mass matrix was obtained. Viscous coupling was similarly taken into account by considering that motions of adjacent cylinders perturb the ordinarily undisturbed axial flow, so that the angle of attack of the flow on a speciic cylinder is modified accordingly. A viscous force matrix was obtained, and it was found that viscous coupling can also be important. The resulting coupled equations of motions (2k equations for a system of k cylinders) were solved to yield the eigenfrequencies and modal shapes of the system.

49975 Outer and inner surface flaws in thick-walled pressure vessels. Atluri, S.N.; Kathiresan, K. (Georgia Inst. of Tech., Atlanta (USA)). pp 1-8 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The objective of this paper is to present the results for stress-intensity factors (SIF) directly computed through a three-dimensional, embedded singularity, hybrid-displacement finite element procedure, for semi-elliptical cracks, of various geometries, located at the outer or inner surfaces of pressurized or thermally shocked thick walled cylinders. Due to length limitation, the paper contains SIF solutions for pressurized cylinders of inner to outer diameter ratios of 4:5,2:3 and 1:2, with pressurized and unpressurized inner semi-elliptical cracks of aspect ratios (b/a=1,2 and.5), at crack depth of b/h=.5 and .8; and with outer semi-elliptical flaws of similar geometries. Results for the above crack geometries in thermally-shocked cylinders are also discussed.

49976 Parametric gross discontinuity interaction finite elements analyses between adjacent nozzles of a vessel. Bergeretto, G.; Lazzeri, L.; Strona, P.P. (SAIGE S.p.A., Via P. Pesce, 5, I-16151 Genova-Sampierdarena, Italy). pp 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The aim of this paper is a brief discussion of the effect of nozzles interaction in a shell in terms of the gross discontinuity stresses. However, while the peak stress distribution in an isolated nozzle has been largely studied in the open literature, there are not many contributions in this particular field. ASME III code serves as a general reference and its nozzles interaction rules will be compared with the results obtained by this analysis. Besides it is the principal aim of this paper to give a critical contribution in order to study the cases where simplified ASME Codes procedures are not applicable, without drawing a quite general conclusion on this topic. The paper is divided into three sections: analytical tools, a parametric analysis of a few cases, a comparison with ASME III code provisions.

49977 Plastic energy dissipation and criteria for stable and unstable fracture. Bhandari, S.K. (Groupement pour les Activites Atomiques et Avancees (GAAA), 92 - Le Plessis-Robinson (France)); Decolon, C. (Conservatoire National des Arts et Metiers (CNAM), 75 - Paris (France)). pp 3/7 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49978 Stresses from pressure, radial, and moment loads in cylinder-to-cylinder vessel by a finite plate method. Brown, S.J. (Babcock and Wilcox Co., Barberton, OH (USA)). pp 1-13 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A problem common to the pressure vessel analyst is the evaluatio . of stresses in nozzle-to-cylinder structures subjected to internal pressure, nozzle axial force, and nozzle moments. In this paper, the finite plate method-discussed by Brown in a paper on nozzle-to-cylinder structures to internal pressure-is extended to include axial force and moments at the nozzle terminus. The purpose is to provide an economical alternative to 3D geometric analytical and experimental stress analysis of such structures.

49979 Finite element, photoelastic, and strain gage stress analysis of a cylinder-to-cylinder structure. Brown, S.J. Jr.; Haizlip, L.D.; Nielsen, J.M.; Reed, S.E. (Babcock and Wilcox Co., Barberton, OH (USA). Power Generation Div.). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper three independent methods are used to evaluate the stresses in a pressure loaded moderately thick cylinder-to-cylinder structure, with a curvature of 1.03. The experimental analyses are performed by strain gage and photoelastic techniques. The analytical analysis employs a three-dimensional isoparametric element with incompatible modes. The purpose is to 1. Provide an excellent benchmark problem, amply verified. 2. Provide further data for cylinder-to-cylinder structures. 3. Provide some assessment of the element accuracy in evaluating such structures. Within the critically stressed area of the juncture of the two cylinders, the data for the three methods are corresponding locations is shown to agree within a 3% variance. The 8-node isoparametric element with incompatible modes is shown to be a comparatively economical and accurate alternative to the experimental structural analysis for cylinder-to-cylinder components. Included within this paper is a brief discussion of the construction and testing the the experimental model and analytical model.

49980 Equivalent nozzle in thermomechanical problems. Cesari, F. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Programma Reattori Veloci). pp 1-6 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

When analyzing nuclear vessels, it is most important to study the behavior of the nozzle cylinder-cylinder intersection. For the elastic field, this analysis in three dimensions is quite easy using the method of finite elements. The same analysis in the non-linear field becomes difficult for designs in 3-D. It is therefore necessary to resolve a nozzle in two dimensions equivalent to a 3-D nozzle. The purpose of the present work is to find an equivalent nozzle both with a mechanical and thermal load interaction, of a different radius. The equivalent nozzle will be a nozzle with a sphere radius in a given ratio to the radius of a cylinder; thus, the maximum equivalent stress is the same in both 2-D and 3-D.

49981 Elastic-plastic analysis of normally intersecting cylinders. Chen, H.C.; Schnobrich, W.C. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). pp 8/2 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49982 Finite element elastic-plastic analysis of initiation and stable crack growth in three-point bending. d'Escatha, Y. (Ecole Polytechnique, 91 - Palaiseau (France)); Devaux, J.C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). pp 1-16 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The behaviour under rising loads of a fatigue crack for instance discovered in a nuclear pressure vessel will exhibit the following stages: initiation, slow crack growth and instability. In the same way these phenomena are observed when testing the material toughness at corresponding temperatures on small specimens. Consequently for understanding these various stages of ductile fracture, it is necessary to develop adequate concepts for material toughness characterization and for their use in predicting the evolution of a surface crack in a nuclear component under monotonically rising solicitations.

49983 U.K. proposal for the assessment of the significance of flaws in pressurized components. Darlaston, B.J.L.; Harrison, R.P.; Loosemore, K.; Milne, I. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). pp 1-10 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A procedure for assessing the significance of flaws in reactor components is described. Using details of the material properties, the stress distribution around the flaw and the nature of the flaw, its growth and propagation can be predicted. Thus, by examining various initial conditions, the consequences of any particular type of flaw may be deduced.

49984 Design and construction of a prestressed concrete pressure vessel for a working pressure of 69 N/mm² (10,000 p.s.i.). Dawson, P. (Taylor Woodrow Construction Ltd., Southall (UK)). pp 1-13 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Construction is nearing completion of a pressure vessel with a chamber 9.15 m (30 ft.) high and 3.05 m (10 ft.) internal diameter for hydraulic tests on marine components up to 69 N/mm² (10,000 p.s.i.) working pressure. The chamber comprises a steel cylinder, with independent end plates contained within a prestressed concrete structure. The cylinder is constructed in two halves, each consisting of three forged rings, 170 mm thick, shrink-fitted onto a 90 mm thick liner. It rests on a 100 mm thick bottom plate, provided with a band of hard-facing overlay on which the cylinder slides in response to changes of test medium pressure. Models to be tested within the chamber are hung from a removeable 150 mm thick top plate. A central elliptical hatch provides access into the chamber. Special sealing assemblies are fitted at the junction of the cylinder sections and between the cylinder and end plates. These seals are capable of accepting radial expansion of the cylinder and corresponding vertical movements at the upper seal arising from elastic movements of the enclosing structure.

49985 Plastic limit load tests of intersecting cylinders. Ellyin, F. (Sherbrooke Univ., Quebec (Canada)). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Cylinder-cylinder intersection is a common configuration of structural components frequently encountered in the industrial installations concerned with the generation of energy such as nuclear reactors, petroleum refineries, pipe lines, etc. To devise simple yet accurate means of designing cylinder-cylinder intersection configurations, one has to resort to empirical formulae supported by experimental and analytical solutions. This paper is concerned with such endeavour from an experimental point of view. The results of series of elastic-plastic deformation tests performed on cylinder-cylinder intersection models made of either welded tubes or machined from a single plate are summarized. An alternate method whereby ASME code compliance could be achieved with a much reduced effort is also discussed.

49986 Method of line applied to 3-D crack problems including plasticity effect. Fu, L.S.; Malik, S.N. (Ohio State Univ., Columbus (USA)). pp 1-17 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Distribution of stress and displacement in structures containing crack-like flaws exhibit three-dimensional nature as well as crack tip stress concentration. Among all the approximate methods in solving these types of problems, the method of line is probably the least known. The Method of Line (MOL) is a method that tends to keep the advantages and discards the disadvantages of both the analytical and grid methods of integration. The idea is to substitute the deriatives with respect to some, but not all, independent variables by finite differences. This approach replaces a given differential equation by a system of differential equations with lower number of independent variables.

49987 Pressure fluctuations induced by fluid flow in singular points of industrial circuits. Gibert, R.J.; Villard, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). pp 1-15 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Flow singularities (enlargements, bards, valves, tees,...) generate in the circuits of industrial plants wall pressure fluctuations which are the main cause of vibration. Two types of pressure fluctuations can be considered. - 'Local ' fluctuations: They are associated to the unsteadiness downstream from the singularity. These fluctuations may be characterized by frequency spectra, correlation length and phase lags. These parameters are used to calculate forces on the walls of the circuit. - 'Acoustic' fluctuations: The singularity acts as an acoustical source; its frequency spectrum and the acoustical transfer function of the circuit are needed to evaluate the acoustical level at any point. A methodical study of the most current singularities has been performed at C.E.A./D.E.M.T.: - On one hand a theory of noise generation by unsteady flow in internal acoustics has been developed. This theory uses the basic idea initiated by LIGHTILL. As a result it is shown that the plane wave propagation is a valid assumption and that a singularity can be acoustically modelled by a pressure and a mass-flow-rate discontinuities. Both are random functions of time, the spectra of which are determined from the local fluctuations characteristics. - On the other hand, characteristics of several singularities have been measured: (i) Intercorrelation spectra of local pressure fluctuations. (ii) Autocorrelation spectra of associated acoustical sources (the measure of the acoustical pressures in the experimental circuit are interpreted by using the D.E.M.T. computer code VIBRAPHONE which gives the acoustical response of a complex circuit).

49988 Material properties and design procedures for arrest of unstable crack propagation in nuclear reactor pressure vessels. Hahn, G.T.; Gehlen, P.C.; Hoagland, R.G.; Kanninen, M.F.; Rosenfield, A.R. (Battelle Columbus Labs., OH (USA)). pp 1/7 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49989 Use of a path independent integral in non-linear fracture mechanics. Hellen, T.K. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.); Blackburn, W.S. (Parsons (C.A.) and Co. Ltd., Newcastle upon Tyne (UK)). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The use of the Rice J-intergral to assess conditions at a crack tip in an elastic or non-linear elastic body is well known. The integral equals the energy release rate and is path independent for any contour surrounding the crack tip provided no other singularities are encompassed. The path independence propertiy breaks down, however, in more general situations such as in three dimensional stress systems, plasticity unloading, thermal or creep states. Hence the required crack tip characteristics represented by the value of the integral round a contour whose radius about the tip tends to zero, is not reproduced along contours away from the tip. Consequently, an alternative integral, designated J*, has been proposed which equals J for elastic cases and in the other cases cited above remains path independent. A computer program for calculating the J and J* integrals has been developed as an extension to the BERSAFE finite element system. A full analysis of the cracked structure including plasticity, creep and thermal strains is conducted and the results are stored on a permanent data set. The integral values may then be calculated using the post-processor program for any number of contours and load or time steps, without recourse to further expensive computations.

49990 Critical evaluation of the tangent modulus method of elasto-plastic fracture analysis. Holt, A.B. (P.E., Nuclear Engineering, Torjusbakken 20, Oslo 3, Norway). pp 1-10 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

How far can one stretch a structure before it fails. Considere (1885) gave the answer for a crack-free structure by looking at the tangent modulus of the uni-axial strain-stress curve using the strain, lambda, for independent variable. The HSST Program developed the Tangent Modulus Method for predicting the behavior of surface cracked structures at various temperatures. The present paper examines the Tangent Modulus Method and assesses its usefulness. The basic formula has been founded on an unproven assumption i.e. that the Neuber Equation (in itself an approximation) may be written using increments of strains and stresses instead of their absolute values. The numerical calculations involve many constants which only are best guess values. The wanted result (a temperature) is entirely suspect because the whole procedure is without solid basis, and the computations are sensitive to propagation of errors.

49991 Procedure for estimating the probability of flaw nondetection. Jouris, G.M.; Shaffer, D.H. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). pp 6/4 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49992 Stress intensity factors of corner cracks in two nozzle-cylinder interactions. Kobayashi, A.S.; Polvanich, N.; Emery, A.F.; Love, W.J. (Washington Univ., Seattle (USA). Dept. of Mechanical Engineering). pp 1-8 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In a recent paper, the authors presented the stress-intensity-magnification factors of a quarter-elliptical surface crack in a quar-

ter-infinite solid and a circular crack approaching a reentry corner in a three-quarter infinite solid. These stress-intensity-magnification factors were used together with a curvature-correction factor to estimate the stress-intensity factor of a corner crack at a nozzle-cylinder interaction. Through appropriate superposition of the above stress-intensity-magnification factors, stress-intensity factors for hypothetical corner cracks at a nozzle-cylinder intersection subjected to internal pressure and transient thermal-stress loadings can be obtained. A description of a computer code based on this procedure as well as its applications in analyzing two corner-crack probems at a nozzle-cylinder intersection are discussed in this paper.

49993 Influence of transverse shear on plasticity around an axial crack in a cylindrical shell. Krenk, S. (Research Establishment Risoe, Roskilde (Denmark)). pp 1-9 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper presents a plasticity model for deep axial surface cracks in pressurized pipes. The model is used in an investigation of the relative merits of fracture criteria based on COD and plastic instability. Recent investigations have shown that the inconsistency of the singular bending stress field in an axially cracked cylindrical shell arising from use of classical 8th order shallow shell theory is removed, when use is made of a 10th order shell theory, which accounts for transverse shear deformations. Although the membrane stresses are only moderately affected, the influence on the bending stresses is considerable. In the case of surface cracks moments are induced to the eccentricity of the crack, and transverse shear effects should therefore be included.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 50319

49994 (FEI—660) **Calculation of critical heat flux in water channels with simple and complex configurations using freon data.** Gorban, L.M.; Pashichev, V.V.; Pomet'ko, R.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1976. 22p. (In Russian). U 03/MF A01.

The article deals with the results of the experimental research of the critical thermal stress on freon-12 for circular tubes and clusters of fuel elements. The experiments on the tubes have been carried out within the following range of the operational and geometric parameters : P = 10.8 - 31.1 atm; length of the tube L = 0.5 - 5 m; weight speed Wγ = (2.7 - 18)x10^6 kg3m^{2}xh; tsub(in)15 - 80 deg C; tube diameter D = 8;12 mm. Drawn is a comparison between the relationships referring to the heat transfer crisis for water and freon-12. The optimum values of the recalculation factors for estimation of the flow rates at various pressures are determined. A method is suggested for determination of the recalculation factors, which is based only of the thermal-physical properties of both fluids. The general nature of the suggested recalculation method with respect to various coolants and various operating conditions is established. The use of the recalculation factors for determination of the flow rates Ksub(G) = 1.3 for the tubes and Ksub(G) = 1.0 for the round rod bundles within the investigated range of the parameters ensures adequate accuracy (sigma < 10%) of recalculations of the data from freon to water.

49995 (FEI—735) **Study of hydraulic characteristics of reactor fuel rod bundles by the dimensionless complex method.** Savkov, K.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 19p. (In Russian). U 02/MF A01.

An analytical method has been developed to study the total hydraulic resistance of fuel rod bundles in terms of dimensionless coolant pressure drops. The method is applied to cylindrical, conical and true prismatic bundles. The formulae of the hydroul'c resistance are presented as power functions of the Reynolds numbe.' at laminar, transient and turbulent flow of the coolant in channels. The method, as contrary to all the others, can be used when only geometric parameters of the bundle and physical characteristics of the coolant circulating therein, are known.

49996 (FEI—741) **Kinetics of stressed-strained state of cylindrical fuel elements with thin-walled envelopes.** Bogush, V.B.; Vakhromeeva, V.V.; Kolesov, V.E.; Likhachev, Yu.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 12p. (In Russian). U 02/MF A01.

Described is the algorithm for solution of the problem relating to kinetics of the deformed-stressed state of the fuel element, which is based on the finite difference method. The nonlinear relationship between the stresses and deformations is reduced to the system of the transcendental equations for the functions describing this relationship. To improve stability of the differential circuitry and convergence of the range method during solution of the finite difference equations, there is introduced a regularization parameter. Considered are cylindrical axially-symmetrical rod-type (solid and hollow) and annular fuel elements with thin-walled jackets. The calculations are performed with due account for the plastic deformation, creep deformation, fuel and jacket swelling, coolant pressure, and irregularity of the temperature field. The calculation results are cited.

49997 (INIS-mf—4470, pp v) **Anisotropic transient deformation of Zircaloy fuel cladding at high temperatures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49998 (INIS-mf—4470, pp v) **New aspects of elasto-plastic fracture mechanics analysis - fuel element cladding as an example.** 1977. (In German).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

49999 (INIS-mf—4498, pp v) **Mechanical and temperature contact in fuel rod cladding.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper presents results for the effect of different types of slip rules on the contact stress distribution. It is shown that the contact shear stress is smaller for the hardening model than for the ideal model. It is also shown that a crack in the fuel increases the contact stresses and that at temperature decrease high tensile stresses arise after eventual welding. It is also shown how particles between fuel and cladding influence the stresses. Also here the effect of eventual welding is studied. The present method is well suited to study cracks and crack propagation. The surfaces of the existing cracks are defined as contact surfaces and the crack extension work is calculated by releasing the nodes at the crack tip. As the crack surfaces are defined as contact surfaces eventual crack closure is automatically taken into account. Crack extension work is calculated for existing cracks in the cladding. It is shown that cracks in the fuel and particles between fuel and cladding will increase the crack extension work.

50000 (INIS-mf—4498, pp v) **Pressure field propagation and mechanical vibration in a subchannel rig driven by a centrifugal blower.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A six rod cluster rig was built to study the structure of turbulent velocity and pressure fluctuations in a closely spaced square-pitched array of rods. The test section contains six 14 cm diameter rods arranged in two four rod subchannels, which are interconnected across one rod gap; spaced at a pitch to diameter ratio of 1.193, and having a total length of 9.14 metre. Walls were inserted in all other rod gap areas, and the effect of these walls on the average velocity distribution in the interconnected gap region was compared numerically to the distribution for an infinite array, and this showed that the effect of the walls was negligible for the chosen pitch to diameter ratio. This fact was confirmed experimentally by Preston tube measurement of the wall shear stress distribution for the top and bottom centre rods, showing that the effect of the wall extended approximately 30° around the rod. An investigation was made of the spectra of the dynamic pressure and the structure vibration for the 45 kW centrifugal air blower; calming entry drum to the rig; and test section, as a function of Reynolds number, for the range of 10^4 to 2.4x10^5. The spectra showed that some of the lower frequency pressure components of the blower were propagating through 15 metre of 20 cm diameter ducting to the drum and test section, and exciting mechanical vibration of the test section. Approximate calculations of the possible flexural mechanical resonances of the system indicated that the frequencies contained in the pressure field were near some of the resonances, which would enhance the flow induced vibration. This far field pressure effect was most evident at the lower R.

50001 (INIS-mf—4498, pp v) **CYGRO-4 fuel rod analysis computer program.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

CYGRO-4 is a finite element computer program for the analysis of axisymmetric deformations of the cross-section of an oxide fuel rod. It is a production program developed from CYGRO-3. Its development has provided a precise, reliable program with up-

to-date physical models and a computational structure adapted for easy revision. Significant developments include time step control based on accuracy considerations, a new fuel-clad and rod-support interaction model, a new thermal conductivity model for the fuel-clad gap, and a new fuel cracking, crack deformation and crack healing model. Input to CYGRO-4 is divided into two parts: rod data and operating history. Rod data comprises quantities characterizing the geometry and physical properties of the rod, including information on clad diameter and thickness, fuel diameter, and fuel and clad thermal conductivities, thermal expansion properties, creep behavior and response to the reactor environment. The operating history consists of the coolant pressure, coolant temperature, reactor power level, and the relevant relationships between power level, fission rate and neutron flux. The program computes the corresponding history of rod temperature, dimensional changes and stresses.

50002 (INIS-mf—4498, pp v) **New version of the LWR fuel performance model WAFER.** 1977.
From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This contribution discusses the latest version, WAFER-2, of the Danish LWR fuel performance code WAFER. The original version, WAFER-1, has previously been published. Modifications in the new version are: restrictions on fuel crack penetration have been completely removed. This implies more accurate stress analysis, hence more realistic creep calculations. Several transversal fuel cracks at arbitrary axial locations (as opposed to one at the mid-pellet position in WAFER-1) are now permitted. This further improves stress analysis and renders the pellet model duly sensitive to interaction forces from the cladding. The total radial crack volume is now evenly distributed circumferentially. This insures better accuracy in the average stress-strain values, at the cost of insignificant local detail. Elastic moduli and other materials properties are now functions of temperature and other operational parameters. The fundamental mode of calculation has been changed: WAFER-1 calculates time step increments of all system variables, to be added to base values from the preceding time point. WAFER-2 does an absolute base value calculation at each time point for all non-integrator variables. This change saves storage and reduces error accumulation. A series of new capabilities has been added to the code: densification, gaseous swelling and fission gas release. The treatment of primary creep and yielding of the cladding has been improved.

50003 (INIS-mf—4498, pp v) **URANUS, a computer code for the thermal and mechanical analysis of fuel rod behavior.** 1977.
From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The URANUS-code follows a first line: a quasi 2d thermal and mechanical integral fuel rod analysis is combined with highly complex material behavior. The quasi 2d solution has been compared with a 2d-finite element solution. An excellent agreement in the axial friction force distribution was found. The mechanical description takes seven components of strains into account: elastic, time-independent plastic, creep, thermal and strains due to swelling, cracking and densification. Models for temperature distributions, heat generation, gap closure, pellet cracking, crack healing, fission gas release, corrosion, O/M distribution and Pu-redistribution are included. The URANUS-code is an advanced fuel rod design code with a variable multizone concept. Geometric nonlinearity (large displacements) are involved, the loads (pressure or temperature) are considered as steady state or transient loads. The crack structure and the axial friction forces are calculated by means of an axial loop. The URANUS code is applicable to every fuel rod type (LWR, LMFBR, HWR). Geometric details as well as material properties are regarded as input parameters. In the paper the new basic mechanical concept, which is a superposition of 1d-radial solution and a 1d-axial solution is given as well as all basic equations. The mechanical concept determines the code structure, which also is shown in detail. Example analysis and comparisons to experiments and results from other codes are given. The result of the present work is the URANUS-code works extremely fast as calculations up to now show.

50004 (INIS-mf—4498, pp v) **Pellet-clad mechanical interaction evaluation.** 1977.
From 15. international Cosmic Ray Conference; Provdiv, Bulgaria (13 Aug 1977).

50005 (INIS-mf—4498, pp v) **Thermomechanical behavior of fuel particles in a matrix during reactor power excursions.** 1977.
From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This work determines the largest particle size that can be used in fabricating fuel material without exceeding temperature or stress criteria during transient operation. To do this temperature distribution histories must be determined for various particle sizes and volume fractions using typical power densities histories of transient reactor operation. From these, the critical stresses are calculated The model chosen to accomplish this is a spherical fuel particle in a spherical matrix shell. Heat flow and temperature continuity conditions are imposed at the interface, and a zero temperature gradient is specified at the outer radius of the matrix shell. The particle power density is assumed to be uniform radially. Provisions are made for uniform power density in the matrix to model gamma heating and power density in interface layers to allow for radiant and fission fragment heating. A computer code was prepared to solve the model performance, yielding the temperature and stress distribution histories. Material property variation with temperature is employed, along with a close mockup of the power density history during self-limiting reactor transients. To date, four fuel systems have been investigated: 1) UC.ZrC particles in graphite; 2) UO_2 particles in graphite; 3) UO_2 particles in chromium 4) UO_2 particles in stainless steel. The study indicates that the maximum allowable particle diameter varies as the square root of the initial transient period and of the particle volume fraction. The critical thermophysical parameter is the thermal diffusivity of the particle, since in all cases studied it is many times smaller than that of the matrix. That of the UC.ZrC solid solution particle is 5 or more times larger than that of the UO_2 particle. It was found that the particles of system 1) above could be about 4 times larger than that of the other systems.

50006 (NIIAR-P—10(304)) **Experimental and analytical study on boiling coolant parameter distribution using a fuel assembly mockup.** Gavrilin, A.I.; Begunova, A.M. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 22p. (In Russian). U 03/MF A01.

Described are the results of the distribution experimental study of the actual volumetric steam content in height and cross-section of the two-cell heated channel simulating the neighbouring cells of the reactor fuel element cluster. The parameters have been studied within the following range: p=3 MPa, thermal load - 400 - 1400 kW/m^2, mass speed of the coolant - 1000 - 3700 kg/C x m^2. The curves showing distribution of the steam content over the channel chords have been plotted . The average values of the steam content in the cells and in the channel as a whole have been determined. Given are the results of calculations of the experimental conditions in accordance with the programs similar to the COBRA, HAMBO and BUNDLE-2 codes. For comparative analysis, three thermal-physical models of the thermodynamically unstable two-phase flows have been used in the program. The difference between the theoretical and experimental results has been analyzed. It is shown that the heat content in the intercellular flows is not equal to the mean heat content of the flow in the donor cell but depends on the flow conditions.

50007 (PNL—2946) **Coordinated irradiation plan for the Fuel Refabrication and Development Program.** Barner, J.O. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1979. Contract EY-76-C-06-1830. 47p. P 03/MF A01.

The Department of Energy's Fuel Refabrication and Development (FRAD) Program is developing a number of proliferation-resistant fuel systems and forms for alternative use in nuclear reactors. A major portion of the program is the development of irradiation behavioral information for the fuel system/forms with the ultimate objective of qualifying the design for licensing and commercial utilization. The nuclear fuel systems under development include denatured thoria—urania fuels and spiked urania—plutonia or thoria—plutonia fuels. The fuel forms being considered include pellet fuel produced from mechanically mixed or coprecipitated feed materials, pellet fuel fabricated from partially calcined gel-derived or freeze-dried spheres (hybrid fuel) and packed-particle fuel produced from sintered gel-derived spheres (sphere-pac). This document describes the coordinated development program that will be used to test and demonstrate the irradiation performance of alternative fuels.

50008 (RE-P—79-043) **Fission product inventories in tests irradiated in PBF.** Olson, W.O. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 128p. P 07/MF A01.

Computered fission product inventories for five tests that have been irradiated in the Power Burst Facility (PBF) reactor are required for use in the evaluation of Fission Product Detection System (FPDS) measurements. These inventories have been calculated using the ORIGEN code. The bulk of this report is an extensive listing of these fission product inventories as a function of time. Calculations were made with the input flux spectrum and the cross sections for the fissionable isotopes adjusted to reflect the spectrum in the PBF in-pile tube. Details of these changes are described.

50009 (WAPD-TM—1148) **Fission-product iodine in thoria/urania oxides (LWBR Development Program).** Clayton, J.C. (Bettis

Atomic Power Lab., West Mifflin, PA (USA)). Feb 1979. Contract EY-76-C-11-0014. 51p. P 04/MF A01.

The ThO_2 fuel from an undefected irradiation test rod depleted to ~ 5 x 10^{20} fissions/cm^3 was leached - first with methyl chloroform to extract any free fission iodine, followed by a second extraction with water to collect chemically-combined iodine ions. Equivalent amounts of ^{129}I were found in each leaching solution. Combined and free iodine (^{131}I) were also measured in extractions from lightly irradiated ThO_2—UO_2 and UO_2 powders. The major portion of the identified combined ^{131}I activity was in the form of iodide ($^{131}I^-$), but both iodate ($^{131}IO_3^-$) and periodate ($^{131}IO_4^-$) were also detected. Most of the intentionally-introduced iodine was retained by unirradiated ThO_2 powders on vacuum annealing up to 700°C and released at 1000°C. The experimental results were correlated with available data on radioiodine release from irradiated ThO_2 and UO_2.

CONTROL SYSTEMS

50010 (BMFT-FB-K—78-04) **Investigation of control rod programs for the variation of the power load of large PWR's.** Kollmar, W. (Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg (Germany, F.R.)). Sep 1978. 57p. (In German). U 04/MF A01.

The efficiency of control rod banks in PWR's with 157 and 193 fuel elements was investigated theoretically with the 2-dimensional EQUIPOISE code. The burn-up influence on the control rod characteristics was determined; the comparison with experimental data from the Obrigheim nuclear power station showed excellent agreement. The damping of axial xenon oscillations by segmented control rods was investigated.

50011 (INIS-mf—4498, pp v) **Impact loading of a BWR control rod during braking.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In an emergency case the control rods of a boiling water reactor are shot into the RPV from below against the dead weight of the rods with drive motors. According to the position of the control rods between the fuel elements the rods can reach in that case velocities up to 4 m/s. The moved masses of the control rods and of the pistons (both of them are connected by a coupling) are braked through a cup spring which transfers its forces to the RPV-bottom sphere. The spring has to be designed that in this case the complete kinetic energy of the control rods of about 1000 Nm can be taken up. The spring power and the inertia of the moved masses cause extremely high loadings during and shortly after the impact onto the spring. The shock-like loading propagates along the whole rod at the speed of sound, and this is also the reason why the weaker cross sections have to endure considerable short-term stress peaks. Because of the dimensions (small width, great length) the calculation could be done one-dimensional on the base of the difference method. For the determination of the deceierations exact mass-modeling was necessary. Thus the stresses can be easily calculated from the forces with the appropriate cross section. The whole model was divided into 145 mass zones (equation of state for austenitic steel), with which a precise survey could be determined about critical position.

ENVIRONMENTAL ASPECTS

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 50572

50012 (STH—17/77) **Emission of Sr-89 and Sr-90 in the gaseous effluents of nuclear power plants with LWR in the Federal Republic of Germany.** Gesewsky, P.; Riedel, H. (Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Strahlenhygiene). Dec 1977. 53p. (In German). U 04/MF A01.

In particular the data of Sr-90 concentrations in the gaseous effluent are given for the years 1975 up to 1977 whereas the data for Sr-89 concentrations are given for the year 1977 only. The strontium is radiochemically separated after dissolution of the aerosolfilters and Sr-89 and Sr-90 are measured by two countings on a low-level β-counter. (Single separation method). From these measurements the following average Sr-90 emission-rates, based on a power generation of 1 GWa, was calculated: BWR's: 2,0 .(period on line) 10^{-5} Ci Sr-90/GWa; PWR's: <= 2,6 .(period on line) 10^{-6} Ci Sr-90/GWa. For the radiologically less important Sr-89 the following average emissionrates, based on a power generation of 1 GWa, were obtianed: BWR's: 3,0 .(period on line) 10^{-4} Ci Sr-89/GWa; PWR's: <= 2,6 .(period on line) 10^{-5} Ci Sr-89/GWa. In comparison to the emission of long-lived radioactive aerosols with the airborne effluent of light water cooled power reactors the Sr-90 contribution is clearly below 1%, usually assumed in safety calculations. (orig./HP) 891 HP.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 49854

50013 **Study of heat transfer processes above a cooling pond.** Hicks, B.B.; Wesley, M.L.; Sheih, C.M. (Argonne National Lab., IL). *Water Resour. Res.;* **13**: No. 6, 901-908(Dec 1977).

Rapid-response instrumentation mounted on a fixed tower located centrally in a strongly heated cooling pond at a nuclear power facility has enabled evaluation of the turbulent fluxes of momentum, moisture, and sensible heat. The results agree well with evaluations based on stability-corrected bulk aerodynamic formulations, provided all atmospheric measurements are made close to the water surface and in a location with adequate upwind fetch. The bulk formulae are those that have been verified recently over more extensive water surfaces, with a minor modification based on the finding that the surface of the cooling pond appears to be significantly smoother than that of open ocean.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 49918, 49944, 50049

50014 (ANL-PMS—79-2(Vol.7)) **World Energy Data System (WENDS). Volume VII. Nuclear facility profiles, AG—CH.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 294p. P 17/MF A01.

In this compendium each profile of a nuclear facility is a capsule summary of pertinent facts regarding that particular installation. The facilities described include the entire fuel cycle in the broadest sense, encompassing resource recovery through waste management. Power plants and all US facilities have been excluded. To facilitate comparison the profiles have been recorded in a standard format. Because of the breadth of the undertaking some data fields do not apply to the establishment under discussion and accordingly are blank. The set of nuclear facility profiles occupies four volumes; the profiles are ordered by country name, and then by facility code. Each nuclear facility profile volume contains two complete indexes to the information. The first index aggregates the facilities alphabetically by country. It is further organized by category of facility, and then by the four-character facility code. It provides a quick summary of the nuclear energy capability or interest in each country and also an identifier, the facility code, which can be used to access the information contained in the profile.

50015 (ANL-PMS—79-2(Vol.8)) **World Energy Data System (WENDS). Volume VIII. Nuclear facility profiles, CO—HU.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 234p. P 11/MF A01.

In this compendium each profile of a nuclear facility is a capsule summary of pertinent facts regarding that particular installation. The facilities described include the entire fuel cycle in the broadest sense, encompassing resource recovery through waste management. Power plants and all US facilities have been excluded. To facilitate comparison the profiles have been recorded in a standard format. Because of the breadth of the undertaking some data fields do not apply to the establishment under discussion and accordingly are blank. The set of nuclear facility profiles occupies four volumes; the profiles are ordered by country name, and then by facility code. Each nuclear facility profile volume contains two complete indexes to the information. The first index aggregates the facilities alphabetically by country. It is further organized by category of facility, and then by the four-character facility code. It provides a quick summary of the nuclear energy capability or interest in each country and also an identifier, the facility code, which can be used to access the information contained in the profile.

50016 (ANL-PMS—79-2(Vol.9)) **World Energy Data System (WENDS). Volume IX. Nuclear facility profiles, IN—PL.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 264p. Dep. NTIS, PC A12/MF A01.

In this compendium each profile of a nuclear facility is a capsule summary of pertinent facts regarding that particular installation. The facilities described include the entire fuel cycle in the broadest sense, encompassing resource recovery through waste management. Power plants and all US facilities have been excluded. To facilitate comparison the profiles have been recorded in a standard format. Because of the breadth of the undertaking some data fields do not apply to the establishment under discussion and accordingly are blank. The set of nuclear facility profiles occupies four volumes; the profiles are ordered by country name, and then by facility code. Each nuclear facility profile volume contains two complete indexes

to the information. The first index aggregates the facilities alphabetically by country. It is further organized by category of facility, and then by the four-character facility code. It provides a quick summary of the nuclear energy capability or interest in each country and also an identifier, the facility code, which can be used to access the information contained in the profile.

50017 (ANL-PMS—79-2(Vol.10)) **World Energy Data System (WENDS). Volume X. Nuclear facility profiles, PO—ZA.** (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 253p. P 12/MF A01.

In this compendium each profile of a nuclear facility is a capsule summary of pertinent facts regarding that particular installation. The facilities described include the entire fuel cycle in the broadest sense, encompassing resource recovery through waste management. Power plants and all US facilities have been excluded. To facilitate comparison the profiles have been recorded in a standard format. Because of the breadth of the undertaking some data fields do not apply to the establishment under discussion and accordingly are blank. The set of nuclear facility profiles occupies four volumes; the profiles are ordered by country name, and then by facility code. Each nuclear facility profile volume contains two complete indexes to the information. The first index aggregates the facilities alphabetically by country. It is further organized by category of facility, and then by the four-character facility code. It provides a quick summary of the nuclear energy capability or interest in each country and also an identifier, the facility code, which can be used to access the information contained in the profile.

50018 (BLG—519, pp 5-18) **BR2 reactor neutron beams.** Neve de Mevergnies, M. 1977.

From An information meeting; Mol, Belgium (24 Nov 1976).

The use of reactor neutron beams is becoming increasingly more widespread for the study of some properties of condensed matter. It is mainly due to the unique properties of the "thermal" neutrons as regards wavelength, energy, magnetic moment and overall favorable ratio of scattering to absorption cross-sections. Besides these fundamental reasons, the impetus for using neutrons is also due to the existence of powerful research reactors (such as BR2) built mainly for nuclear engineering programs, but where a number of intense neutron beams are available at marginal cost. A brief introduction to the production of suitable neutron beams from a reactor is given.

50019 (CEA-N—1982) **Gamma spectrometric measurements of power distribution and burnup on irradiated fuel elements of light water reactors.** Bouchard, J.; Frejaville, G.; Robin, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Dept. des Reacteurs a Eau). Aug 1977. 77p. (In French). U 05/MF A01.

Based on experience gained from experiments at the COMIR laboratory and with the installation at the Adennes reactor and on the use of these results for evaluation of calculation methods, this report includes a synthesis of the aspects concerning in particular non-destructive measurement of irradiated fuel in water reactors, fuel assemblies or fuel pins. Following a brief summary of gamma emitting radioactive fission products and, measurement conditions, there is a description of the fuel cooling installation at the Ardennes reactor, including the results obtained with this installation as well as from measurements on the fuel pins. In conclusion, the problem concerning burn-up determination, especially the $^{134}Cs/^{137}Cs$ method, are discussed.

50020 (HEDL-SA—1728-FP) **Neutron source strength in FFTF fuel as a function of irradiation.** Ombrellaro, P.A.; Petrowicz, N.E. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1979. Contract EY-76-C-14-2170. 20p. (CONF-790602—74). P 02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

The neutron source strength associated with fuel irradiated in the FFTF reactor is important in determining the reactivity of the core when it is shut down or being refueled. The monitoring of subcritical reactivity for FFTF will be done with the Modified Source Multiplication (MSM) technique which requires an accurate knowledge of the neutron source strength in high exposure fuel elements replaced with fresh fuel elements in a shut down reactor. As a means of obtaining the most accurate source evaluations possible with existing nuclear data for FFTF irradiated fuel, a technique for generating one-group actinide cross sections for use in isotopic buildup and depletion codes was developed. A further objective of the work was to use the cross sections and recently evaluated spontaneous fission and (α,n) reaction neutron yield data to calculate the neutron source strength in typical compositions of FFTF-type fuel as a function of flux level and irradiation time and then to compare the results with those of a previous study to assess the differences in the nuclear data. This paper will highlight the important aspects of this study and present some results.

50021 (HEDL-SA—1766) **Stress analysis of conical flued heads for FFTF liquid metal piping anchors.** Sampson, R.C. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1979. Contract EY-76-C-14-2170. 33p. (CONF-790615—17). P 03/MF A01.

From 3. US national congress on pressure vessels and piping; San Francisco, CA, USA (25 Jun 1979).

Flued heads for liquid metal piping were designed to function as structural anchors for liquid metal piping and as atmospheric seals between compartments. Their design was complicated by the need to provide high strength and rigidity as piping anchors, yet to have the flexibility needed to accommodate severe thermal differential temperature gradients under both steady state and transient conditions. Conical flued head design configurations in sizes from 1" to 28" were evolved by the repeated application of detailed thermal and stress analysis methods. Stress indices characterizing the response to each basic load type, were derived from the finite element analyses, followed by evaluations of performance by the elevated temperature ASME Code rules for elastic analysis and by the simplified one-dimensional analysis under the rules for inelastic analyses. Based upon this work, slight modifications of the design were made before authorizing production in order to enhance the resistance to creep damage. It was later demonstrated that the most critically stressed flued heads under the most extreme operating conditions complied with the Code rules for detailed inelastic stress analysis.

50022 (IAE—2780) **Neutron spectrum of the gaseous cavity fuel assembly with an external heavy water moderator in the energy range of $O < E < 5eV$.** Chuvilin, D.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 19p. (In Russian). U 03/MF A01.

Integral neutron spectra have been measured in a spherical gaseous fuel assembly mockup with a heavy water moderator in the 1-5 eV energy range. The technique of stationary neutron source (^{252}Cf) placed in the centre of the cavity filled with BF_3 enriched by ^{10}B up to 81.7% is used. Spatial distributions of spectral indexes of ^{164}Dy, ^{151}Eu, ^{115}In, ^{193}Ir and ^{198}Au are tabulated. The measurements have been performed in the BF_3 pressure range from 0 to 6 bars which corresponds to the ^{235}U concentrations from 0 to 6.88×10^{20} atom/cm^3 being critical for the assembly. The measured dependences are compared to the calculated ones, carried out using the SI-5 code written in a 15-group P_3 approximation. The experimental and calculated indexes for all investigated indicators (except for europium) are close in value.

50023 (INIS-mf—4498, pp v) **Parametric analysis of fuel can designs for a Safety Test Facility.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50024 (INIS-mf—4498, pp v) **Development of a (U, Zr) C-graphite pulsed reactor fuel element.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A new core is being designed to improve the performance of the Annular Core Pulse Reactor (ACPR). This design utilizes a two region core with the inner region containing high enthalpy fuel elements around the 228 mm diameter central irradiation cavity. An outer core region of uranium-zirconium hydride fuel elements is placed around the high-enthalpy inner core region to provide an adequate negative temperature coefficient for the entire core. A program has been conducted to develop a high-enthalpy fuel element using a graphite matrix fuel containing (U-Zr)C solid solution particles. Since the (U,Zr)C-graphite fuel is subjected to a reactor period of two milliseconds with a large temperature gradient across the fuel diameter, fracture due to thermal stresses is the primary failure mode. The development program optimized this class of fuel for pulsed reactor application. A variety of graphite-based fuels were fabricated by the Materials Technology group of the Los Alamos Scientific Laboratory, and the details of this fabrication have been previously reported. Fuel specimens were fabricated by both extrusion and hot pressing using low thermal expansion graphite flour with uranium densities from 345 to 800 mg/cc. Mechanical and thermophysical characterization studies were performed to determine elastic modulus, fracture strength, thermal expansion, enthalpy and thermal conductivity in order to perform thermal and structural analyses. Fuel specimens with a diameter of 33 mm were tested without fracture in the ACPR to peak temperatures in excess of 2000°C with radial peak-to-minimum energy deposition profiles of 2.0 to 3.0.

50025 (INIS-mf—4498, pp v) **Subassembly bowing experience in EBR-II.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Subassembly bowing in an LMFBR can affect core neutronics, subassembly handling, and possibly create a potential safety hazard if the phenomenon can not be characterized and predicted. Bowing may be induced by thermal gradients, differential swelling, and/or intersubassembly loading. Neutronic variations, such as long or short term power-reactivity decrement (PRD) variations, can be indicators of a bowing problem. But, because of other influences on the PRD it is very difficult to isolate the affect of bowing. As a result, subassembly bowing was not considered a problem in EBR-II until subassembly handling problems occurred. A typical handling problem, caused by top end deflection of the bowed subassembly, is centering of the subassembly removal mechanism over the subassembly. Another problem is excess loads of up to 375 kg that have been required to remove bowed subassemblies from their grid position. This latter problem is due in part, to the magnitude of bow and subassembly stiffness in addition to the overall subassembly cluster tightness caused by duct swelling and/or the occurrence of multiple bowing. Observed interferences in storing a bowed subassembly in the storage basket can be used as a qualitative gauge for bowing magnitude. In EBR-II a storage basket tube can accomodate a subassembly bow of 2.3 to 3.1 mm depending on the position in the basket. All of the bowed type 304 stainless steel subassemblies that created handling difficulties were given a post-irradiation examination. Damage that may have been caused by interference loading was found to be limited to surface scratches. The measured bow of these subassemblies range from 1.9 mm for a fueled subassembly to 5.7 mm for a neutron-source-rod thimble.

50026 (INIS-mf—4498, pp v) **Structural analysis of experimental carbide fueled driver assembly flow duct for testing in the FFTF.** 1977.
From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Mixed carbide fueled driver assembly experiments will be tested in FFTF fuel driver positions as part of the National Advanced Fuel Program. The design of the experimental flow ducts must assure conformance to FFTF functional requirements in addition to service as a test vehicle for the carbide fuel irradiations. Test goals of damage fluence, burnup, and fluence to burnup ratio exceed those of the standard oxide fueled drivers. As a consequence, the 20% cold worked type 316 stainless steel material of construction will experience significant irradiation induced creep and swelling. Additionally, the flow duct design must withstand the enhanced thermal transients produced by the action of carbide fuel during reactor scrams. A major FFTF functional requirement is that adjacent flow ducts do not touch each other except at the load pads. This requires a realistic analysis of the creep and swelling deformation of the flow duct during an experiment lifetime. Flow duct dilation, i.e., diametrical growth of the hexagonal cross section, was investigated by the MARC-CDC finite element program. Subroutines for irradiation creep and swelling were incorporated into the program. The model for the 2-D duct dilation analysis was a transverse slice through one-half of one hexagonal cross section flat (midflat to corner). The ends were free to slide outward. Generalized plane strain modelling was required to satisfy boundary conditions and high stress gradients in the corner.

50027 (INIS-mf—4498, pp v) **Proof tests of irradiated EBR-II ducts.** 1977.
From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Permanent deformation and fracture of subassembly ducts due to potential pressure pulses generated by the discharge of fission gas from fuel elements are important considerations in determining the burnup limit of fuels in LMFBR's. This paper discusses the results of a series of dynamic pressure tests that were conducted on intentionally defected irradiated EBR-II subassembly ducts. The tests were designed to simulate failure of a fuel element in a cluster of such elements. The major objective of the tests was to provide complete assurance that cladding failure of a driver-fuel element, which might conceivably cause rapid release of stored fission gas, would not deform or otherwise damage subassembly ducts in a way that would hinder movement of a control rod. Although rapid failure of a driver-fuel element in its plenum region to cause a pressure pulse is an extremely remote event, even for loss-of-flow conditions in EBR-II, the occurrence of such an event cannot be adequately disproved analytically in discussions of reactor safety. An experimental approach was therefore adopted to show -if possible- that such failure would not result in significant damage to irradiated ducts. Hindrance of movement of a control rod could then be precluded.

50028 (NIIAR-P—7(301)) **Economic estimate of the test reactor exploitation efficiency.** Brun, V.N.; Kirillov, E.V. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1977. 16p. (In Russian). U 02/MF A01.
The specific features are shown of scientific researches on the experimental reactor which is actually a multipurpose test-experimental plant intended for gaining experience in operation of a new type reactor under the NPP conditions. There is described a principal approach to estimation of the economic efficiency of these researches. There is suggested a parameter which provides for quantitative estimation of the efficient use of the experimental opportunities of the entire reactor. This parameter is represented by the relative scope of the experimental operations on the plant per unit expenditure. This parameter makes it possible to estimate the degree of use of the existing experimental opportunities of the plant and efficiency of the measures aimed at extension of these opportunities. With the use of this parameter, it will not be difficult to determine the absolute value of the economic effect.

50029 **Closed Loop In-Reactor Assembly (CLIRA)--A Fast Flux Test Facility test vehicle.** Oakley, D.J. (Westinghouse Hanford Co, Richland, Wash). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 78-WA/NE-6, 1-15(Dec 1978).
The Closed Loop In-Reactor Assembly (CLIRA) is a test vehicle for in-core material and fuel experiments in the Fast Flux Test Facility (FFTF). The CLIRA is a removable/replaceable part of the Closed Loop System (CLS) which is a sodium coolant system. The primary purpose of the CLIRA is to provide a test vehicle which will permit testing of nuclear fuels and materials at conditions more severe than exist in the FTR core and to isolate these materials for the reactor core. This paper characterizes the elements that comprise the CLIRA, and presents the requirements that established the design, describes the design, and evaluates the design conformance to the requirements. 7 refs.

50030 (DOE-tr—180) **DERAN; computer program for identification of radioactive nuclides in measured gamma spectra.** Jacobi, S.; Letz, K.; Schmitz, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). 5 Jul 1978. Translation of KFK—2447, April 1977. 97p. P 05/MF A01.
The computer program DERAN (Detection of Radioactive Nuclides) was developed to evaluate gamma spectra measured by Ge(Li) detector systems at the HSD loop of the FR2. This program is written in Fortran IV and divided into several blocks: establishment of a relationship between channel number and gamma energy of the corresponding photo peak; detection of photo peak; determination of the position and the count for the photo peak; identification of gamma-emitting nuclides; and calculation of corresponding activities. The first three blocks are run through in each calculation; the last two are optional. The spectra are fed into the computer on perforated tapes or magnetic tapes; a printer is used to output the results. Evaluation of a spectrum requires a maximum core storage of 240°K and a maximum computation time of 30 sec.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 50572

50031 (AERE-R—9210) **2DT, 3DT and 2DS - two- and three-dimensional transient and two-dimensional steady state heat-transfer finite-difference computer programs.** Kennedy, T.D.A. (UKAEA, Harwell. Atomic Energy Research Establishment). Aug 1978. 115p. U 06/MF A01; Also available from H.M. Stationery Office, price Pound2.50.
Technical assessment of accident conditions in nuclear reactors, and many problems in other fields, require the solution of the transient temperature distribution in solid regions in contact with flowing fluids. In this situation the fluid temperatures are dependent on heat transfer between the fluids and the solids, and so these temperatures cannot be supplied as preset boundary conditions. The transient programs deal with this problem by a method used in the three-dimensional program RAT-3D. This method uses a two-step iteration procedure in which solution of the set of time-dependent heat-conduction finite-difference equations alternates with solution of the heat-balance equations for Newtonian cooling so that a new set of boundary conditions are obtained for the next solution of the heat-conduction equations. The set of heat-conduction equations are solved by the alternating-direction method. The two-dimensional steady-state program, 2DS, cannot accept internal coolants, and must be supplied with temperatures and heat-transfer coefficients for all external boundaries. It is simpler to use than the transient program in that no time history is required, and its use is therefore preferred for the solution of steady-state problems which do not contain internal coolants. Radiation between solid regions and to the outside environment is allowed for in all the programs. Thermal expansion is taken into account for heat transfer across radial gaps between solid materials. The programs are written to keep input data simple and computing costs low.

50032 (ANL-RDP—81) **Reactor development program progress report, March 1979.** (Argonne National Lab., IL (USA)). 16 May 1979. Contract W-31-109-ENG-38. 121p. AT.

This progress report summarizes the Argonne National Laboratory work performed for the Reactor Development Program during March 1979 in the following research and development areas: Safety, Engineered Systems and Components, Physics, Gas Cooled Breeder Reactor, Test Facilities - ANL, and EBR-II Fuel Fabrication Costs Inventory Account.

50033 (ANL-RDP—82) **Reactor development program. Progress report.** (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 181p. AT.

This progress report summarizes the Argonne National Laboratory work performed for the Reactor Development Program during April 1979 in the following research and development areas: safety, engineered systems and components, physics, gas cooled breeder reactor, and test facilities - ANL.

50034 (ANL-RDP—83) **Reactor development program. Progress report.** (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 119p. AT.

This progress report summarizes the Argonne National Laboratory work performed for the Reactor Development Program during May 1979 in the following research and development areas: safety, physics, fuel and absorber development, test facilities - ANL, and EBR-II fuel fabrication costs inventory account.

50035 (CAAP-TR—048) **Assessment of the capability of the existing heat transfer data base and of designated data sources to privide data over the calculated heat transfer variable ranges during a LOCA blowdown.** Larson, J.R. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 88p. P 05/MF A01.

Data for transition boiling, film boiling and critical heat flux are compared to code calculated heat transfer variable ranges to determine whether the data are sufficient to support the calculations during the blowdown phase of a postulated loss of coolant accident. The data were selected from the Heat Transfer Data Bank. RELAP4/MOD5, RELAP4/MOD6 and TRAC-P1 calculated heat transfer variables of mass flux, pressure, quality, heat flux, and surface temperature are used in the study for the core and steam generator components of PWR and Semiscale systems. The various heat transfer regimes used by the codes for the core and steam generator are determined and a comparison of the usage is presented. Test facilities designated to provide heat transfer data during blowdown are evaluated with respect to their capability to provide data for heat transfer correlation development and testing. Conclusions and recomendations concerning the calculated heat transfer variable ranges and the data are presented.

50036 (CONF-790423—1) **Development of a nonequilibrium ECC mixing model for use in RELAP4/MOD7.** Fischer, S.R. (EG and G Idaho, Inc., Idaho Falls, ID); Chow, H.; Van Arsdall, G.; Stadtke, H. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 4p. P 02/MF A01.

From 2. multiphase flow and heat transfer symposium workshop; Miami Beach, FL, USA (16 Apr 1979).

The nonequilibrium mixing model, which interfaces with the existing homogeneous equilibrium calculational scheme used in RELAP4, is described in detail. Preliminary comparisons between code calculations using the mixing model and experimental data are presented for Westinghouse Electric cold leg ECC injection tests, Battelle Columbus Laboratories and Creare ECC bypass tests, and LOFT and Semiscale tests. These code—data comparisons indicate the need for consideration of nonequilibrium effects in code simulations of the ECC bypass refill phase of postulated LOCA transients. In addition, these results point out the need for continued development of constitutive relations for use in modeling steam water mixing phenomena.

50037 (CONF-790646—6) **Overview of the LOFT experimental program.** Burtt, J.D. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 13p. P 02/MF A01.

From International colloquium on irradiation for reactor safety programmes; Petten, Netherlands (25 Jun 1979).

The Loss-of-Fluid Test (LOFT) facility, operated by EG and G Idaho, Inc., for the US Nuclear Regulatory Commission, is designed as an integral test facility to study the behavior of commercial pressurized water reactors (PWRs) during a loss-of-coolant accident (LOCA). For this mission, six nuclear and one nonnuclear test series have been proposed to provide data on PWR transient behavior, but plans must be recognized as tentative and subject to change for a number of reasons. The Nonnuclear Test Series, completed in April 1978, consisted of six loss-of-coolant experiments (LOCEs) performed with isothermal primary coolant temperatures. The Power Ascension Test Series, Series L2, proposes five LOCEs, simulating double-ended cold leg breaks (DECLB), to provide a controlled power escalation to a peak power of 52.49 kW/m. The Small and Intermediate Breaks Test Series, Series L3, will consist of three LOCEs designed to study the effects of smaller primary coolant system ruptures. These tests will be initiated by cold leg ruptures ranging from scaled 6.4-cm pipe ruptures to scaled 0.05-m^2 pipe cracks. Five LOCEs are proposed for the Alternate Emergency Core Cooling Systems (ECCS) Test Series, designated Series L4. These DECLBs will be used to study systems such as lower plenum emergency core coolant injection, hot leg injection, and combined hot and cold leg injection. Also included in the L4 series is a test involving upper plenum-downcomer pressure equalization valves. The Hot Leg Rupture Test Series, Series L5, will study PWR behavio. during a double-ended hot leg rupture.

50038 (CONF-790816—12) **Dual change-of-phase in forced flow on a finite wall, with application to SLSF safety analysis.** El-Genk, M.S.; Moore, R.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 11p. P 02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

An important study related to the safety analysis of Liquid Metal Fast Breeder Reactors (LMFBRs) is to understand the phenomena of molten fuel relocation and refreezing on the core cold structures following a hypothesized loss-of-flow accident (LOFA). An assessment of molten fuel containment capability for the Sodium Loop Safety Facility (SLSF) in-pile experiments following a postulated LOFA is presented, considering the conditions of molten fuel flow, simultaneous melting in the outer duct wall, and convective cooling at the outer surface of the wall due to sodium coolant bypass flow.

50039 (CONF-790827—1) **Nonlinear dynamic analysis of nuclear reactor primary coolant systems.** Saffell, B.F. Jr.; Macek, R.W.; Thompson, T.R.; Lippert, R.F. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 17p. P 02/MF A01.

From ADINA conference; Cambridge, MA, USA (1 Aug 1979).

The ADINA computer code is utilized to perform mechanical response analysis of pressurized reactor primary coolant systems subjected to postulated loss-of-coolant accident (LOCA) loadings. Specifically, three plant analyses are performed utilizing the geometric and material nonlinear analysis capabilities of ADINA. Each reactor system finite element model represents the reactor vessel and internals, piping, major components, and component supports in a single coupled model. Material and geometric nonlinear capabilities of the beam and truss elements are employed in the formulation of each finite element model. Loadings applied to each plant for LOCA dynamic analysis include steady-state pressure, dead weight, strain energy release, transient piping hydraulic forces, and reactor vessel cavity pressurization. Representative results are presented with some suggestions for consideration in future ADINA code development.

50040 (FEI—778) **Calculation of nonstationary two-dimensional temperature field in a tube wall in burnout.** Kashcheev, V.M.; Pykhtina, T.V.; Yur'ev, Yu.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1977. 16p. (In Russian). U 02/MF A01.

Numerically solved is a nonstationary two-dimensional equation of heat conduction for a tube wall of fuel element simulator with arbitrary energy release. The tube is heat-insulated from the outside. The vapour-liquid mixture flows inside the tube. The burnout is realized, when the heat transfer coefficient corresponds to the developed boiling in one part of the tube, and to the deteriorated regime in the other part of it. The thermal losses are regarded on both ends of the tube. Given are the statement of the problem, the algorithm of the solution, the results of the test adjusting problem. Obtained is the satisfactory agreement of calculated fixed temperature with experimental one.

50041 (GEFR—14023-6/7) **Risk analysis methods development. Sixth—Seventh quarterly reports, April—September 1978.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Oct 1978. Contract EY-76-C-03-0893-032. 48p. AT.

Progress is reported for the following subtasks in risk analysis methods development for LMFBRs: Lines-of-Assurance (LOA) supporting analysis, consultation with LOA working groups, and methods and procedures development.

50042 (GEFR—14023-9) **Risk analysis methods development. Ninth quarterly report, January—March 1979.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Apr 1979. Contract EY-76-C-03-0893-032. 51p. AT.

Progress in LMFBR risk analysis methods development is reported under the following headings: (1) task planning, management and liason; (2) Lines-of-Assurance (LOA) supporting analysis; (3) consultation with LOA working groups; and (4) methods and procedures development.

50043 (GEFR—14034-16) **Radiological assessment models. Sixteenth quarterly report, June—August 1978.** (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Sep 1978. Contract EY-76-C-03-0893-032. 25p. AT.

This report, the sixteenth in a series of quarterly reports published under the Radiological Assessments program, documents work performed from June 1978 to August 1978. The objective of the program is to develop models based on analyses and experiments which determine: (a) radiological source terms resulting from hypothetical, energetic and melt-through core disruptive accident scenarios, and (b) radiological source term attenuation within containment. Test data pertaining to fuel and fission product release from burning and boiling sodium pools were examine to determine the mechanisms which control such releases. The data were found to be inadequate to determine conclusively the processes involved. A theoretical investigation is in progress to identify controlling parameters, develop correlations between them, and define experiments. Sensitivity studies over the range of uncertainty in decontamination factors indicate the risk is acceptable for the extremely low probability accidents considered in lines of assurance three and four. It is expected the risk could be significantly reduced if more test data were available.

50044 (GEFR-SP—171) **Response of secondary containment to presence of sodium and hydrogen.** Gleikler, E.L.; Huang, T.C. (General Electric Co., Sunnyvale, CA (USA). Advanced Reactor Systems Dept.). Jul 1979. Contract EY-76-C-03-0893. 15p. (CONF-790810—2). P 02/MF A01.

From 2. international seminar on containment of fast breeder reactors; Berlin, F.R. Germany (9 Aug 1979).

As part of an effort to demonstrate that the risk to the public from extremely low probability events in liquid metal fast breeder reactors is bound within an acceptable envelope, containment pressurization by sodium and hydrogen was evaluated. Temperature and pressure histories are presented for typical sodium spray and pool fires and sodium vapor reactions. A review of mechanisms for hydrogen generation and recombination as well as limit for flammability and autocatalytic recombination is provided, and general containment design options to reduce risk are discussed.

50045 (GRS-F—66) **Reports on research projects in the field of reactor safety sponsored by the Federal Minister for Research and Technology. Period under report: April 1 to June 30, 1978.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Sep 1978. 673p. (In German). U 09/MF A01.

Investigations on the safety of Light Water Reactors (LWR) being performed in the framework of the Research Program Reactor Safety (RS - Projects) are sponsored by the BMFT (Federal Minister for Research and Technology), der Bundesminister fuer Forschung und Technologie. Objective of this program is to investigate in greater detail the safety margins of nuclear power plants and their systems and the further development of safety technology. Besides the investigations of LWR tasks first projects on the safety of FBR type reactors are sponsored by the BMFT. The GRS (Reactor Safety Association), Gesellschaft fuer Reaktorsicherheit mbH, by order of the BMFT, informs continuously of the status of such investigations by means of quarterly and annually publication of progress reports within the series GRS - F Fortschrittsberichte (GRS - F - Progress Reports). Each progress report represents a compilation of individual reports about objectives, the work performed, the results, the next steps of the work etc. The individual reports are prepared in a standard form by the contractors themselves as a documentation of their progress in work. The individual reports are arranged according to the amended LWR Safety Research Program of the BMFT. Another table contents uses the same classification system as applied in the Nuclear Safety Index of the CEC Communities and the OECD. (orig./HP) 891 HP.

50046 (HEDL-SA—1552-S) **Fission gas behavior in mixed-oxide fuel during transient overpower and simulated loss-of-flow tests.** Randklev, E.H.; Hinman, C.A. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 12p. (CONF-790306—23). P 02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

A portion of the fission gases (Xe, Kr) generated during steady state irradiation of an FBR mixed-oxide fuel is retained within its microstructure, especially in the cooler regions of the fuel. Information on the behavior of these retained gases relative to their microstructural relocation and release during off-normal power and coolant flow conditions is important to the analysis and analytic modeling of fuel-pin transient and reactor core performance. This paper discusses the steady state and transient behavior of retained fission gas relative to the geometry, microstructure, temperature, and apparent release mechanisms within selected axial and radial regions of fuel pins irradiated at medium power (7 to 10 kW/ft) and burnup (30 to 60 MWd/kgm). The specific fuel pins are from the PNL-10 and PNL-2 subassemblies irradiated in EBR-II. The transient overpower tests involved integral fuel pin static capsule experiments performed in TREAT. Loss-of-coolant flow was simulated in an out-of-reactor thermal transient testing system using axial segments of irradiated fuel pins.

50047 (HEDL-SA—1686) **Recent aerosol tests in the Containment Systems Test Facility.** McCormack, J.D.; Hilliard, R.K.; Postma, A.K. (Hanford Engineering Development Lab., Richland, WA (USA)). Oct 1978. Contract EY-76-C-14-2170. 21p. P 02/MF A01.

The Containment Systems Test Facility (CSTF) is a 20-meter high, 850m³ model containment vessel in which various sodium fire aerosol air cleaning tests are studied for purposes of developing and proof testing air cleaning techniques. The first series of tests was designed to study the properties of sodium fire aerosols without any air cleaning and to provide a data base for model verification using large-scale experiments. To date, three such tests (two pool fire and one spray fire) have been completed and are being analyzed. These tests will be discussed, as will plans for the air cleaning tests to follow.

50048 (IDO—1570-T14) **Estimators for the binomial failures rate common-cause model.** Atwood, C.L. (Idaho National Engineering Lab., Idaho Falls (USA)). 1979. Contract EY-76-C-07-1570. 57p. P 04/MF A01.

In Vesely's binomial failure rate model, a system of m components is hit by random shocks which may cause components simultaneously to fail, each component with equal probability. Individual components may also fail when no shock has occured. The data possibilities considered are those causes of single failures that are identifiable (as shock or not) or not identifiable. Given data from such a system, non-Bayesian and Bayesian point and interval estimators are found for the various quantitites of interest. Residual analyses and hypothesis tests are presented for checking the model assumptions. An example is worked out.

50049 (IDO—1570-T15) **LOFT monthly progress report for June 1979.** (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-07-1570. 69p. P 04/MF A01.

Following the very successful conduct of LOFT experiments L2-3 and L3-0 in May, the project emphasis shifted toward removal of the center fuel module changeout was performed to verify by physical inspection that the fuel configuration was unaffected by the two nuclear and one nonnuclear loss-of-coolant tests that simulated a 200% break in the primary cooling system. In addition to preparation for fuel changes, reviews were started to examine the budget and work scope impact associated with accelerating small break tests now planned for FY-81. Recommendations will be made in July to the Nuclear Regulatory Commission about the desirability of and problems associated with such a program change. Costs in June continued at less than budgeted levels. This resulted from savings achieved to date, rescheduling and deferrals associated with program orientation changes, and uncosted but incurred liabilities. The cumulative underrun and the projected cost to complete for FY-79 are now under intensive review in order to balance funding against desired program changes. This review will be completed in July.

50050 (INIS-mf—4243) **Role of the IAEA nuclear safety guidelines and recommendations.** Konstantinov, L. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Power and Reactors). 1978. 13p. (CONF-7710184—19).

From IAEA specialists meeting on the effect of regulatory requirements on nuclear power plant control and instrumentation systems; Madrid, Spain (4 Oct 1977).

The rapid growth of nuclear power which is projected in many countries has made it necessary for the International Atomic Energy Agency to develop and publish internationally acceptable safety standards for Nuclear Power Plants (NPP's). It was envisaged that these standards should be developed in the form of a set of recommendations and minimum requirements for ensuring safety and reliability of NPP's. The standards would serve as a unified frame of reference to which Member States could refer in taking main decisions on nuclear safety.

50051 (INIS-mf—4492, pp v) **Theoretical study of aircraft impact on reactor containment structures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50052 (INIS-mf—4492, pp v) **Inelastic behavior of reinforced concrete structures submitted to induced vibrations of aircraft impact or gas cloud explosion.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50053 (INIS-mf—4492, pp v) **Calculation of forces arising from impacting projectiles upon yielding structures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Calculations concerning the impact of airplanes upon nuclear power plant buildings usually imply that the building 'acts' as a rigid target. This assumption is justified for considerations concerning the structural integrity of the building being hit. However, for investigating induced vibrations of components within the structure, this approach might -in general- be too conservative. It is expected, that yielding of the structure during impact reduces the peak values of the loads and changes the temporal behavior of the load function which is obtained for a rigid target. To calculate the changes of the load function which are due to deformations of the structure, Riera's method is extended for the case of a yielding target. In view of the applications of the calculations to the impact of airplanes upon buildings which are constructed to withstand loads of this kind without serious damage and without large deformations, it is possible to simplify the calculations to some extent. That is, the investigations need not take into account in detail the behavior of the target during impact. The calculations are performed with a one-dimensional model for the projectile. The direction of impact is perpendicular to the target surface; direction of impact and projectile axis coincide. The calculations were performed for several initial velocities of the projectiles simulating a fast flying military airplane. Variations of the peak values of the load functions as compared to corresponding values for a rigid target do not exceed about 10%. The overall temporal behavior of the load curves turns out to be not very sensitive to the yielding of the target, though, in some cases displacements in time of the peak positions within a single load curve do arise.

50054 (INIS-mf—4492, pp v) **Numerical analysis of impact-penetration problems for nuclear reactor safety.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper discusses the finite element and finite difference analysis of two impact penetration problems, namely a fuel cask drop on a foundation slab and a missile penetration into a reinforced concrete structure. For a realistic detailed analysis, advanced techniques were required in the following areas: reinforced concrete simulation; remeshing algorithms for penetration induced distortions; boundary condition. The fuel cask drop on a concrete slab generates complex elasto plastic waves which propagate towards the pool where tensile cracks might appear. The problem is analysed in two steps: calculation of the energy absorbed locally around the impacted area; calculation of the three dimensional wave propagation towards the pool. For the analysis of missile penetration problems, two examples are shown: a 3000 kg missile with a velocity of 132 m/s penetrates a 1.2 m thick concrete wall (PAM-GDYNS) and a 3600 kg missile with a velocity of 90 m/s (F.D. Program HEMP-ESI) penetrates a wall at a floor level.

50055 (INIS-mf—4492, pp v) **Structural response of reinforced concrete slabs to impulsive loads.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The structure treated here is a clamped circular slab of reinforced concrete. The loading is a rectangular pulse uniformly distributed over a central area. The practical value of this problem is that it probably represents a most severe loading case for bending response among more realistic cases, because it replaces the local loaded area with a circular area at the slab center, and because it replaces the pulse with a rectangular pulse of the same peak pressure and impulse. In the theoretical treatment the pulse is assumed to produce plastic deformations large enough to neglect elastic deformation but small enough to neglect membrane action. Yielding of the reinforced concrete slab is assumed to be governed by the Johansen criterion and the associated flow rule. For simplicity, the analysis is restricted to isotropic slabs with top and bottom steel reinforcement arranged to provide the same yield moment magnitude for positive and negative curvature changes. A consequence of the assumed rigid-perfectly plastic behavior is that the deformation modes may be considered as simple mechanism governed by a yield circle. Moreover, the yield circle is stationary while the constant pressure is being applied and expands to the support once the pressure is removed. After the yield circle has arrived at the support, the remaining deformation occurs in the static collapse mode. The principal results are explicit simple formulas for permanent central deflection in terms of pressure, duration, loaded area radius, and plate properties (radius, density, yield moment).

50056 (INIS-mf—4492, pp v) **Specific problems concerning aircraft impact on nuclear containment vessels.** 1977. (In French).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Due to the high population density, in Belgium PWR power plants are designed against aircraft impacts. A double wall is used for the containment shield. The lack of relevant data and specifications for such a loading on the non-prestressed external wall led us to determine the suitable safety criteria, the most appropriate materials to be used and the corresponding limit state design through dynamic and plastic analysis. Our technical choices and calculation results are summarized below. The safety criteria consisted mainly in adopting an ultimate limite state design for the allowable compression stress on concrete and the yield stress for the allowable tension stress on reinforcement. The plastic caiculations have been carried out by successive approximations of the final state instead of a step by step analysis. An elastic dynamic analysis for an impact at the top of the dome has been made with the MARC program. It justified a D.L.F. of 1.15 for the shear forces. The ULS design without crack limitation made the use of high strength steel for the main reinforcement fully efficient. This allowed an important saving on the reinforcement cost. Static and dynamic tests have been carried out on high grade bars. Among other interesting results these tests showed a strain velocity of 100% per sec. and an increase in the ultimate strength under rapid loading.

50057 (INIS-mf—4492, pp v) **Conditions of external loading of nuclear power plant structures by vapor cloud explosions and design requirements.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In the design of nuclear power plant structures in the Federal Republic of Germany (FRG) the external loading by pressure waves from unconfined vapor cloud explosions is taken into account. The loading conditions used are based on simplified model considerations for the sequence of events which generates the pressure wave. The basic assumption is that the explosion of unconfined vapor clouds can evolve only in the form of a deflagration wave with a maximum overpressure of 0.3 bar. The research on gas explosions conducted in the FRG with a view to external reactor safety just as similar work in other countries demonstrates that there are still various problems which need further clarification. The principal issues are the maximum conceivable load and the modes of structural response. This paper presents the main results of a status report commissioned by the German Federal Ministry of the Interior in which the whole sequence of events leading to the external loading of nuclear power plants and the corresponding response of the structure was scrutinized. Constitutive in establishing the status report have been thorough discussions with experts of the various fields. The following problems areas are discussed in the paper: incidents leading to the release of large amounts of liquefied gas; formation of explosive vapor clouds, ignition conditions; development of the explosion, generation of the pressure wave; interaction between pressure wave and reactor building. It is outlined where definite statements are possible and where there are uncertainties and information gaps.

50058 (INIS-mf—4492, pp v) **Auxiliary equipment response to an aircraft crash in a typical PWR nuclear power plant.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50059 (INIS-mf—4492, pp v) **Local response of reinforced concrete to missile impacts.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50060 (INIS-mf—4492, pp v) **Dynamical load factor of impact loaded shell structures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Dynamical loaded structures can be analysed by spectral representations, which usually lead to an enormous computational effort. If it is possible to find a fitting dynamical load factor, the dynamical problem can be reduced to a statical one. The computation of this statical problem is much more simpler. The disadvantage is that the dynamical load factor usually leads to a very rough approximation. In this paper it will be shown, that by combination of these two methods, the approximation of the dynamical load factor can be improved and the consumption of computation time can be enormous.

50061 (INIS-mf—4492, pp v) **Penetration theory for axisymmetric projectiles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper presents a simple dynamic cavity expansion approach to the penetration of slender, axisymmetric, rigid projectiles into compressible, strainhardening targets under axisymmetric conditions. Furthermore, it is not reasonable to expect a single theory to cover all targets and all velocities of impact. A non-dimensio:

number has been defined to provide parameter for discussion of scaling and range of validity of the theory. Basic assumptions of Goodier, Hanagud and Ross theories have been retained. After imbedding, the compressive normal stress at the nose tip is assumed to be given by the spherical cavity expansion theory that corresponds to the smaller of the cylindrical radii at the target surface or the base, instantaneous velocity and acceleration of the projectile. The resulting expression for the normal stress consists of a part p that depends on the target intertia and a part p which does not. Following Goodier, p is assumed not to vary along the nose (frontal surface) of the projectile. The variation of p along the frontal surface is obtained in two different ways. The first approach is to generalize Goodier's cosine variation to accommodate conical and ogival nose shapes. The second approach follows an approximate representation of target particle velocity v and acceleration a. Basic frame work for this representation is as follows. (a) A particle at the nose tip moves with the instantaneous projectile velocity. (b) Component of v normal to the projectile nose is equal the corresponding component of projectile velocity. (c) v is continuous along the nose. (d) Relative a fixed observer, tangential component of v is zero at the base. (e) The variation of tangential component of v between nose tip and nose base follows from similar problems in fluid mechanics.

50062 (INIS-mf—4492, pp v) **Analytic modeling of the impact of soft missiles on protective walls.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Analytic models are derived from principles of conservation of energy and momentum as well as common engineering assumptions to describe the perpendicular impact of deformable missiles on yielding walls with an ideal plastic behavior. Such modeling is of interest in making risk analyses for nuclear plants where the impact of crashing aircraft or wreckage from nearby explosions must be considered. The description of th soft missile postulates the existence of a stationary deformation zone in the immediate vicinity of the wall. Deformation is confined to those portions of the missile which enter into this zone. This study considers energy conservation as applied to missile and wall. The concept of a crushing-energy per unit missile length is introduced, which may be seen as an equivalent to the crushing-load used in previous work. In addition, the model allows for residual kinetic energy of the deformed portion of the missiles as they might leave the impact zone. This residual energy is subject to certain limitations due to the available energy and restriction of reaction forces to compression only. Based on this model and the assumption of unyielding walls, solutions are obtained for the reaction-force history from the impact of missiles characterized by parameters and conditions covering a wide range of cases of pratical interest. This is applied to the case of the impact of a FB-111 jet aircraft, which commonly has been employed as a reference case in reactor safety studies. While for high impact velocity the reaction-force-history approaches the shape of the crushing-energy function, significant deviations are found at lower velocities.

50063 (INIS-mf—4492, pp v) **Experimental and analytical research on the behavior of reinforced concrete slabs subjected to impact loads.** 1977. (In German).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Within research program on reactor safety, initiated by the Ministry of Research and Technology (BMFT) of the Federal Republic of Germany, the behavior of reinforced concrete slabs subjected to impact loads is studied. This research is essentially divided into two parts: the investigation of the behavior of deformable projectiles when striking nearly rigid targets as well as the measurement of the resulting impact force against time. The projectiles of tubular shape have the following dimensions: length about 6.00 m, diameter 0.60 m, maximum weight 10 KN, maximum velocity on impact is about 300 m/s. The results of these tests are needed to prove the basic assumptions underlying theoretical models. These theoretical models are used for the calculation of impact loads arising from a deformable projectile striking a rigid target. The examination of the bearing capacity of reinforced concrete slabs under short time loads. In these tests the loads are produced by the above described deformable projectiles. The slabs have the dimensions length/width 6.50/6.00 m, thickness 0.40...0.60 m. All measured quantities are compared with the results of numerical calculations. The expected research progress will not allow the first experimental results to be available before the beginning of the conference. Therefore, this paper is concerned with the theoretical work, required for the analysis of reinforced concrete slabs under impact loads. The influence of the parameters, used in assumed constitutive equations for reinforced concrete slabs is discussed together with several simplifications of the plate theory.

50064 (INIS-mf—4492, pp v) **Local and global response of reactor buildings at the loadcase aircraft impact.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50065 (INIS-mf—4492, pp v) **Overview of major aspects of the aircraft impact problem.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50066 (INIS-mf—4492, pp v) **Projectile penetration of earth media.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Penetration of a projectile into earth is a function of parameters which describe the impact velocity, size, shape, weight, and material properties of the missile, and the unconfined compressive strength of the earth material. Increased velocity, weight, and hardness of the missile material increase the penetration. A sharper nose also leads to deeper penetration, but stronger earth reduces it. The formula for depth of penetration takes into consideration all the important parameters which influence this penetration. The earth can be rock or soil. The soil can be uniform or layered, for which an averaging technique is used. The water table may vary. Results predicted by the proposed formula have been compared with full-scale test results. In the tests, the missile and soil characteristics varied widely. The soil varied from competent rock to very soft clay. The impact velocities of the projectiles were in both the subsonic and supersonic regions. Though the penetrations varied from a few feet to several hundred feet, the differences between the predicted and full-scale test results were within three percent of each other. Formulas are given for the determination of the deceleration and velocity time histories of the penetrating projectile. These easy-to-use formulas are developed considering the phenomenon of contact pressure between colliding bodies. Predicted results compare well with the results obtained by other analytical methods. The proposed method has been extended to missile impact on concrete barriers. Comparisons between predicted and test results for impact on concrete barriers show very good correlation.

50067 (INIS-mf—4492, pp v) **Barrier design for tornado-generated missiles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Nuclear powerplant facilities and many other structures need protection against missiles generated by tornadoes and explosions. The missile impacts result in both local and overall effects on barriers or targets. The local effects are characterized by penetration, perforation, and backface spalling or scabbing of the target material. The overall effects of missile impact on structural stability are commonly evaluated in terms of the flexural and shear behavior of the target. Empirical formulas are presented to determine the local effects on concrete and steel barriers. Procedures are given for determining the design loads for overall effects. Design methods are described.

50068 (INIS-mf—4492, pp v) **Spalling of concrete walls under blast load.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A common effect of the detonation of explosives in close proximity of concrete shield walls is the spalling (scabbing) of the back face of the wall. For explosions close-in to the wall, where the reflected blast wave pressures are sufficiently high, multiple spall layers are formed. Successive spall layers are of increasing thickness, at the same time the spall velocities decrease. For a given wall configuration and peak blast wave pressure the spall thickness scales directly with the cube root of the charge weight. The spall velocities on the other hand, which are proportional to the impulse trapped in the spall layer, vary only slightly with charge weight due to minor differences of shock attenuation in the wall. For a given charge weight, the spall thickness increases with stand-off distance from the wall and the spall velocity decreases. For fixed charge stand-off distance the spall thicknesses decrease as the charge weight is increased, at the same time spall velocities increase. This is caused by the steeper pressure decay associated with higher blast wave pressures. Fixing the charge parameters, spall thicknesses increase slightly as the wall thickness is increased. The opposite holds for the spalling velocities. As the angle of incidence for the blast wave increases the spall thicknesses increase also. Again the corresponding spall velocities decrease. Assuming elastic concrete behavior, no spalling will occur for angles of shock wave incidence greater than 45°. A phase reversal of the reflection coefficient occurs at this point.

thus the longitudinal wave reflected at the free surface becomes a compression wave.

50069 (INIS-mf—4492, pp v) **Analysis of the impact of an aircraft crash on underground concrete ducts with protective slab at reactor buildings.** 1977. (In German).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper different types of idealization for a dynamic analysis of underground concrete ducts with protective slab are discussed and compared. Ducts between reactor and control building of a nuclear power plant are to be designed for loadings produced by an aircraft crash. These ducts have a height of about three to four meters and are two to eight meters wide. They are designed with a protective slab about 1.5 m in thickness at ground level and with an intermediate layer of earth of about one meter in thickness. An analysis has to take into account the combined effects of a protective slab with a relatively thin intermediate layer of earth and the underlaying duct and layer of soil with the nonlinear behavior of concrete due to cracking. For describing this behavior two types of idealization were made. One type is a continuum type calculation which describes the slab, the soil and the duct by finite elements. In the other type of idealization a model consisting of springs and lumped masses is used. The protective slab and the intermediate layer of earth may be described as a plate on elastic foundation. The behavior of the cracked part of the plate and the part of earth layer beneath and loads transferred to the uncracked part of the slab and the surrounding soil may be described by parallel springs. Spring and mass of this part of the model have to take into account the cracking of the upper slab which leads to a nonlinear characteristic of the spring. In addition the location of the loading in relation to the duct has to be considered. The duct may be described by a beam on elastic foundation which is loaded locally. From this model representative mass and spring have to be determined.

50070 (INIS-mf—4492, pp v) **Analysis of accidents in petroleum industry. Determination of TNT equivalent for hydrocarbons.** 1977. (In French).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This study has been developed for evaluating safety of nuclear plants in industrial vicinity. For example, one of the possible accidents is the failure of a storage tank or a pipeline, involving release and vaporization of the product, then formation of a vapor cloud which can disperse, expand and result in explosion. Then we have to determine TNT equivalent of hydrocarbons for evaluating blast damage from accidental explosions, predicting eventual effects for nuclear plants. Literature gives different answers about this subject and shows that the TNT equivalence concept for a non-ideal explosion is not well understood at the present time. Then we have listed a number of typical incidents in which damaging blast waves have been produced. 74 recent characteristic accidents were examined.

50071 (INIS-mf—4492, pp v) **Response of a reactor building and its equipment to aircraft crash.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The present study investigates the dynamic response of the ASEA-ATOM BWR 75 reactor building in terms of response spectra at significant locations considering various aircraft and points of load application. In the first part of the study a total of 21 forcing functions, most of them from the open literature and including the commonly used standard functions, have been studied with respect to documentation, consistency and frequency content. Since none of the forcing functions have been experimentally verified, their validity must be assessed mainly by judging the structural models and assumptions used in their derivation and by checking their consistency. In the second part, linear dynamical models of various degrees of detailedness have been investigated regarding their capacity to describe the behavior of the reactor building under this high frequency loading. The most detailed model consists of plane stress finite elements for every significant wall and floor. In the third part of the study the effects of a number of parameters on the response of the building are investigated. The parameters include the points of attack, damping values, soil spring stiffness as well as different forcing functions of various frequency contents. The reponse is displayed as response spectra and member forces for characteristic locations. The results serve as a basis for development of standardized design floor response spectra and for the structural verification of the building.

50072 (INIS-mf—4492, pp v) **Longitudinal dynamic analysis of preloaded systems due to repetitive impact-loading.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50073 (INIS-mf—4492, pp v) **Behavior of reinforced concrete barriers subjected to the impact of tornado generated deformable missiles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper presents a general model for the evaluation of local effects damage including, penetration and backface spalling, of reinforced concrete barriers subjected to the impact of deformable tornado generated missiles. The model is based on an approximate force time history which assumes: 1) the initial penetration of the missile occurs without significant deformation of the missile if the strength of the missile is greater than that of the barrier. This portion of the time history is represented by a linear and finite rise time; 2) wrinkling or collapse of the missile occurs when the critical stress of the missile is exceeded (during collapse it is assumed that negligible penetration takes place). This portion of the time history is represented by a constant force-time relationship; 3) while the missile is penetrating and wrinkling both elastic and plastic stress waves are developed in the missile, and compressive and shear stress waves are generated in the target. When the shear waves reach the backface of the slab, diagonal cracks initiating at the end of the penetrating missile are formed. These cracks propagate to the backface reinforcing where splitting cracks are formed; 4) repenetration of the missile occurs after the wrinkling has caused a change in missile cross section. This repenetration results from moving the failure cone described in three above, and is also represented by the constant force time history. Using the above assumptions, relationships for the penetration depth of the missile, the wrinkling length of the missile, the critical missile stress, the time history of the impact and the spalling of the target are developed.

50074 (INIS-mf—4492, pp v) **U.S. regulatory requirements for blast effects from accidental explosions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper is limited to accidental explosions external to nuclear power plants. Procedures for deciding if the risk of damage due to an accidental explosion is sufficiently high to warrant detailed study and methods for assessing structural capability when detailed study is needed are described. The dynamic blast load effect may be estimated by a simplified static procedure. The regulatory staff permits use of a dynamic load factor of 2 applied to the overpressure or reflected pressure, as appropriate, and the assumption that structures and structural elements will deform dynamically as though the loads were applied statically. This assumption allows the designer to compute stresses, moments and shears without reference to the distribution of inertial forces within the structure. Blast pressure should be considered to act both inward and outward to account for dynamic stress reversal. Overturning and sliding stability as well as the ability of supporting structures to carry loads transmitted from the directly loaded exterior surfaces must be assessed. A detailed dynamic analysis in which force-time histories and the stiffness and mass properties of the structures are employed is also acceptable. Damping is not important for air blast effects. The regulatory staff requires that blast effects be resisted elastically. This is consistent with regulatory philosophy that global loading situations should not be permitted to cause global damage. Appendix C to ACI-349, 'Code Requirements for Nuclear Safety Related Concrete Structures', in conflict with regulatory requirements, permits a ductility of 3 for blast loadings.

50075 (INIS-mf—4492, pp v) **Gas explosions and their effects upon reactor components relevant to plant safety.** 1977. (In German).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Under the Reactor Safety Program launched by the German Federal Ministry for Research and Technology studies have been carried out in order to obtain an insight into the complex pattern of events involved in the generation of chemical explosions and their effects upon the environment. The main parameters measured first were the propagation functions of exploding ethylene, propane and methane/air mixtures of various concentrations with different ignition sources in thin walled polyethylene balloons and tubes. While, in the detonative ignition case, quantities as low as 8 g and 80 g of high explosive, respectively, were sufficient to initiate gas detonations in stoichiometric ethylene and propane/air mixtures, it was not possible to initiate detonations in methane/air mixtures even with 2500 g of explosive; merely shock waves supported by the combustion process developed which, after a certain distance, changed to subcritical deflagration. When igniting with flames, exploding wires and pyrotechnical ignition fuses (deflagrative ignition), no events resembling detonation were observed. The maximum flame velocities were around 10 m/s, in turbulent regions close to and outside of the balloon also a factor of 3-4 higher. The overpressures in the interior of the reacting mixtures were less than 0.1 bar. Experiments

in balloons up to 500 m^3 furnished consistent results. Similar results were also obtained in the tube experiments in which, despite severer boundary conditions than those existing in a free cloud, no significant flame acceleration could be found in the case of deflagrative ignition even after the installation of turbulence generating internals.

50076 (INIS-mf—4492, pp v) **Structural design for aircraft impact loading.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The distribution of military aircraft and proximity to commercial air routes requires the analysis of aircraft impact effect on nuclear power plant facilities in Europe. The 'hardened-building' approach has led to the consideration of severe shock and vibration caused by the aircraft impact and development of corresponding floor response spectra for component design. The reactor auxiliary system building allows a more defensive alternate in the form of a partially softened design. In this approach the equipment layout is arranged such that equipment performing either safety functions or having the potential for significant release of radioctivity (upon destruction) is located in the central area of the plant and is enclosed in thick concrete walls for shielding and protection purposes. The non-safety class equipment is arranged in the area peripheral to the hardened central area and enclosed in thin concrete walls. Since the kinetic energy of the impacting aircraft is absorbed by the collapsed thin walls and ceilings, the vibrational effect on the safety class equipment is drastically reduced. In order to achieve the objective of absorbing high kinetic energy and yet reduce the shock and vibration effects, the softened exterior walls require low resistance and high ductility. In order not to increase the construction cost, and yet to assure the safety of the plant, some dynamic tests of conventionally reinforced slabs have to be performed all the way to collapse. These calculations have assumptions of achieving the maximum velocity instantaneously after impact, and take into account the kinetic energy in the broken wall. Nonlinear equations of motion are also formulated and solved. The results indicate that the phantom jet would go through the first wall. The second wall would stop the jet, but would sustain some permanent deformation and damage.

50077 (INIS-mf—4492, pp v) **Design of concrete containments for aircraft impact.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50078 (INIS-mf—4492, pp v) **Extreme load resistant design of nuclear power plant structures.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50079 (INIS-mf—4492, pp v) **Full-scale tornado-missile impact tests.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes a test program in which reinforced concrete panels were impacted by poles, pipes and rods propelled by a rocket sled. The objective was to generate full-scale data for use in designing nuclear facilities against postulated impacts from tornado-borne debris. Of particular interest was the determination of impact velocities below which reinforced concrete walls are invulnerable to backface scabbing. The panels had thicknesses typical of nuclear power balance-of-plant walls and roofs and were constructed to current minimum standards. Test missiles and velocities included representing current design standards. The four missile types tested were: 1500-pound 35-foot-long utility pole; 8-pound 1-inch reinforcing bar; 78-pound 3-inch pipe; 743-pound 12-inch pipe. The test panels were 12, 18 and 24 inches thick with 15-foot-square unsupported spans. They were constructed with a concrete design strength of 3000 psi (actual strength averaged about 3700 psi) and 0.3% reinforcing steel area each way at each face (12-inch spacing). Panel edges were supported against a 3-foot deep, 1-foot wide reaction beam with grout between the beam and panel to assure uniform support. Load cells behind each corner of the reaction beam measured impact loads transmitted to the 40-ton fixed backup structure. Test results showed that the utility pole, 1-inch rebar, and 3-inch pipe impacting at greater than current design velocities do not produce backface scabbing even in the thinnest (12-inch) panel tested. The front several feet of the poles disintegrated upon impact without damaging the face of the panels. The 12-inch pipes penetrated the face of the panels, but at the current maximum design velocity (154 fps) caused no backface scabbing (secondary missiles) in 18- and 24-inch panels. For a 12-inch panel the threshold velocity for scabbing was about 95 fps.

50080 (INIS-mf—4492, pp v) **Impact load time histories for viscoelastic missiles.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Generation of the impact load time history at the contact point between a viscoelastic missile and its targets is presented. In the past, in the case of aircraft striking containment shell structure, the impact load time history was determined on the basis of actual measurements by subjecting a rigid wall to aircraft crash. The effects of elastic deformation of the target upon the impact load time history is formulated in this paper. The missile is idealized by a linear mass-spring-dashpot combination using viscoelastic models. These models can readily be processed taking into account the elastic as well as inelastic deformations of the missiles. The target is assumed to be either linearly elastic or rigid. In the case of the linearly elastic target, the normal mode theory is used to express the time-dependent displacements of the target which is simulated by lumped masses, elastic properties and dashpots in discrete parts. In the case of Maxwell viscoelastic model, the time-dependent displacements of the missile and the target are given in terms of the unknown impact load time history. This leads to an integral equation which may be solved by Laplace transformation. The normal mode theory is provided. The target structure may be composed of different materials with different components. Concrete and steel structural components have inherently different viscous friction damping properties. Hence, the equivalent modal damping depends on the degree of participation of these components in the modal response. An approximate rule for determining damping in any vibration mode by weighting the damping of each component according to the modal energy stored in each component is considered.

50081 (INIS-mf—4492, pp v) **Structural response of a concrete wall to blast load.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50082 (INIS-mf—4492, pp v) **Simplified method of analysis of sacrificial shield wall for pipe whip restraint load.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The sacrificial shield wall is analyzed for the pipe whip load which is particularly important for the safety analysis and failure predictions of a concrete reactor pressure vessel. The location of the shield wall makes it a very important structure for the support of the pipe whip restraints. The sacrificial shield wall is a composite structural steel and plain concrete, open-ended cylindrical shell structure stiffened by stiffening rings and vertical stiffeners. The restraint reaction loads act over a small area and are assumed to be concentrated and local loads on the sacrificial shield wall. The response of the sacrificial shield wall to the restraint-reaction load is assessed in terms of local effects and overall structural response which can be treated separately but are interrelated in actuality. Due to the complex physical processes involved with the analysis, local effects are evaluated primarily by the application of ring theory and the overall structural response by the beam theory. Local effects are evaluated considering a sector ($-45^0 <= \text{theta} <= 45^0$) of a ring of mean radius 'a' and subjected to a concentrated (two-pulse loading) dynamic load of magnitude 'F' at center ($\text{theta} = 0^0$). Overall effects are evaluated by considering a cantilever cylindrical beam of mean radius 'a'. An effective spring and effective mass are used to represent the most contributing ring mode from the ring analysis described earlier into the beam model. The results of the simplified approach are compared with the results by the bending theory.

50083 (INIS-mf—4492, pp v) **Comments on the effect of the three external load cases - earthquake, airplane crash, outer explosion - on the design of buildings and equipment of nuclear facilities - a comparison.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50084 (INIS-mf—4492, pp v) **Response of equipment to aircraft impact.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

As the aircraft impacts on a small area of the structure only, and the corresponding function of the load versus time exhibits a substantial content of high frequency, the modelling of the structure has to be rather detailed. Several thousand dynamic degrees of freedom in a finite-element idealization result, when analyzing e.g. a typical reactor auxiliary building, the familiar lumped-beam models used successfully for earthquake analysis can obviously not be

chosen. This is demonstrated using the reactor building, the reactor auxiliary and the fuel-handling building of a typical 1000 MWe plant. For an adequate finite-element model, the influence of the load vector and of the stiffness matrix, damping matrix and mass matrix on the response is analyzed. The parametric study leads to the following results. From the analysis of a Boeing 707 and of the fighter Phantom with and without freely flying debris, it is concluded that for constant peak load, constant total impulse and constant duration of load, the actual shape of the load-time relationship is of paramount importance. For an elasto-plastic behavior of the material, the response is also significantly changed. But even for extremely simple systems, the nonlinear response cannot be predicted a priori. Compared to the result of an elastic analysis, it can turn out to be increased or diminished. Introducing damping, leads to smaller response, this effect being more pronounced as the distance to the point of impact is increased. Finally, the representation of the mass (lumped, consistent) is of minor importance. Using the standard load-time curves, an elastic analysis leads to accelerations of the structure in the vicinity of the applied load of several tens of g. Even for rather remote points the response is still considerable.

50085 (INIS-mf—4492, pp v) **Collapse of chimney with impact on reactor building.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The behavior of the chimney for the loads has to be investigated, as a possible collapse onto adjacent safety-relevant structures (reactor building, reactor auxiliary building, fuel-handling building). The loading cases which might cause a collapse are outlined. The mathematical models used to calculate the highly physically and geometrically non-linear behavior are described. The resulting response of the structures subjected to impact is determined and compared to that caused by other external extreme loading conditions. The safe-shutdown earthquake is represented by an artificially generated time history which fits a specified design-response spectrum. For preliminary calculations the response for simple sine wave excitation is determined. The ground acceleration at which collapse first occurs is calculated for different soil parameters and dimensions of the chimney. Overall consideration of the balance of energy and of impulse as well as detailed solutions of the resulting differential equations of motion are performed. These investigations are carried out on models of increasing complexity starting with the idealisation of the chimney as a rigid bar on a rigid, tensionless foundation and leading up to an elastoplastic representation of the structure and of the soil. When impacting onto adjacent buildings, the latter are always considered as being rigid. This allows a load-time relationship to be constructed, which, in a second independent step, is used in the dynamic analysis of the building subjected to impact. Several different failure modes of the chimney are examined. The scope of this paper is to determine the overall response of the structure and of its equipment.

50086 (INIS-mf—4492, pp v) **Theoretical and experimental study of the crash of a model of an irradiated fuel container.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

During handling of the container within the reactor containment, its shock absorber casing is removed, and it is possible that after an accidental crash a loss of protection or tightness may occur. Three crash tests with 1/5 scale models weighing 800 kg each have been performed at the Centre d'Etudes Scientifiques et Techniques d'Aquitaine (CEA, Bordeaux). - The models were cylindrical and composed of an internal steel vessel surrounded successively by lead, plaster compound and an external steel vessel. A rigid internal load simulated the fuel. The first model fell flat from 10 m. The aim of this prudent crash was to test the experimental apparatus and to be able to make preliminary numerical comparisons for a not much deformed model. The second and the third one fell from 27 m which is a realistic height for the 1/1 scale container. The second fell flat and the third one fell on an angle. The numerical calculations have been run with the PASTEL code of the CEASEMT system of structural mechanics programs. The main difficulties came from the modeling of the structure where several contact non-linearities existed; mainly, the slipping of the lead protection on the internal vessel and the fact that the internal load was just laid on the bottom of the internal vessel. Three numerical models have been tested, each best suited to calculate a particular effect. A reasonably good agreement has been obtained between calculation and experiment with regard to the duration of the impact and the amplitude of the main deformations ie: overall model shortening, lead slipping.

50087 (INIS-mf—4492, pp v) **Fuel element transport container - calculation of the effects of a drop into the storage pool.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The effects of a postulated drop of the fuel element transport container into the storage pool were computed. The storage pool is a thick walled, water filled concrete cylinder, which is located directly beside the fuel element storage pool proper. Between both pools there is a gap through which the fuel elements can be transported below water. Together with the container the wall material behavior and height of fall were varied. The main task of the calculation was to find out the pressure wave which comes from the impact of the container on the water surface and which continues at the speed of sound in the water, is reflected on the bottom and comes back again. Because of two reasons a precise information is necessary; a drop should not be a faulted condition and therefore the density of concrete had to be guaranteed; at the bottom of the pool there is a bumper construction which is being kept dry from the water by a metal plate. This bumper should only catch up the falling container without being filled with water unless the container hits the plate. Therefore the support of the metal plate had to absorb the pressure energy. On the whole 5 cases are considered within this study: 1) normal container, stiff wall, height of fall 2.30 m; 2) like cases 1, but with the concrete wall in the mathematical model; 3) like case 2, but reduced height of fall of 0.90 m; 4) like case 3, but 50 times stiffer transport container; 5) like case 3, but twice as much reinforcement.

50088 (INIS-mf—4492, pp v) **Structural dynamic analysis on the BWR containment system subject to pool dynamic loads.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50089 (INIS-mf—4492, pp v) **Structural considerations-BWR MARK I pool dynamics.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50090 (INIS-mf—4498, pp v) **Transient non-boiling heat transfer in a fuel rod bundle during accidental power excursions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The physical problem studied is the transient non-boiling heat transfer of a cylindrical fuel rod consisting of fuel, gap, and cladding to a steady, fully developed turbulent flow. The fuel pin is assumed to be located in the interior region of a subassembly with regular triangular or square arrangements. The turbulent velocity field as well as turbulent transport properties are specified as functions of the coordinates normal to the axial flow direction. The heat generation within the fuel may be specified as an arbitrary function of the three spatial coordinates and time. A digital computer program has been developed. On the basis of finite-difference techniques, to solve the governing partial differential equations with their associated subsidiary conditions. Results have been obtained for a series of exponential power transients of interest to safety of liquid-metal and water cooled nuclear reactors. The general physical features of transient convective heat transfer as explored by previous investigators have qualitatively been substantiated by the present analysis. Emphasis has been devoted to investigate the differences of heat-transfer (coefficient) results from multi-region analysis including a realistic fuel rod model and single-region analysis for the coolant region only. A comparison with the engineering relationships for turbulent liquid-metal cooling by Stein, which are an extension of the heat transfer coefficient concept to account for transient heat fluxes, clearly demonstrates that, at the parameters studied, Stein's approach tends to largely overestimate the convective heat transfer at early times.

50091 (INIS-mf—4498, pp v) **Bowing and corresponding thermal stress phenomena in fuel pins during transients.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Although the thermal mechanical behavior of fuel pins has been studied in detail for steady-state conditions, much less attention has been paid to these problems during transients. The present paper deals with bowing and thermal stress phenomena in fuel pins during blow-down transients. By means of FEM the transient circumferential temperature distribution is analysed in a zircalloy cladded UO_2 fuel pin, for a representative spectrum of parameters. The transient heat transfer coefficient at the outer-cladding wall are obtained from out-of-pile flow-down experiments. Solutions for both temperature dependent and independent material properties are given. The results show that the circumferential temperature variations in the canning are more pronounced during transients as compared to steady-state conditions. The influence of the gap resistance remains small. Thermal stresses and related fuel pin bowing phenomena remain within acceptable limits.

50092 (INIS-mf—4498, pp v) **Probabilistic models for fuel rod damage during an LWR LOCA.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A computer model MCRF has been developed for estimating the number of fuel rods puncturing during an LWR LOCA due to the pressure acting over the clad. MCRF is planned to be coupled with the multi-purpose fission product release code ACCREL. It is expected that the MCRF model is best applicable, and also most useful, in cases where the failed rod fraction is in the range 0.1-10%. The reactor core is divided into up to 15 rod groups, each of which consists of an arbitrary number of like fuel rods. The damage fractions in the rod groups and the whole core and their statistical error limits are determined. The statistics of variables are either local, that is, different in each rod group, or global, that is, the same in the entire core. Different distributions and truncation limits are allowed. To achieve a reasonable consumption of processing time, the degree of detail in the physical and mathematical models have been chosen so that there is a reasonable balance between the quality of available input data and approximations in the model. The modular structure of ACCREL and MCRF codes makes it easy to improve any submodel when necessary and possible. The program allows the user to choose between two different failure criteria: simple rupture strength vs. rupture temperature curve derived from burst tests, and a more flexible method based on the concept of life fraction integral. The strengthening effect of clad oxidation is included in the model. Systematical space dependent effects within fuel bundles can be considered too. In addition to estimating the damage fraction, the program can, as an option, also supply an estimate of flow channel blockage.

50093 (INIS-mf—4498, pp v) **Development of advanced method for fuel seismic analysis.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper explains briefly about the procedures of fuel seismic evaluation in which the combined FUVIAN and FLOAN methods are applied and then explains about the details of analytical methods of both codes together with various verification tests for them. On the seismic evaluation of fuel assembly, first the colliding vibration of fuel assemblies is analysed by using FUVIAN and the maximum grid impact force and the worst fuel assembly deformation are obtained. The impact force can be evaluated by comparing it to grid crush strength. Next, for the worst deformation, FLOAN analyses detailed stresses and strains in the fuel components such as fuel rod and control rod guide thimble. The method of FUVIAN3 is basically the same in governing equations of vibration as of FUVIAN2, but it is essentially improved in impact force calculational model. In FUVIAN2, each fuel assembly was treated as single beam fashion with a pair of impact elements at each grid position. But in FUVIAN3, the fuel assembly is treated as it consists of several sub-beams connected each other with spring network which corresponds to a fuel grid, so that we can deal with the complex grid-rods interaction mechanism in distributed mass manner. The validity of above method was confirmed for both impact force and displacement predictions by full scale fuel assembly impact test. In FLOAN model, a fuel assembly is idealized such that it consists of elastic beams (fuel rods and guide thimbles) and rigid bodies (nozzles and grids) in which any arbitrary connecting conditions of free, fixed and elastic can be available. The non-linear effect arising from spring and dimple type rod support is treated as an equivalent elastic connection.

50094 (INIS-mf—4498, pp v) **Stress and deflection analysis of a typical PWR fuel assembly due to seismic and maximum hypothetical LOCA loading conditions.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The present investigation summarizes the development of a unique method of analysis for predicting the most critical dynamic response of a typical 950 MWe PWR fuel assembly subjected to simultaneous occurrences of seismic and LOCA loads in which individual responses are superimposed directly. The paper discusses mathematical modelling and analysis techniques, whereby important subcomponents of the assembly, such as gapped end springs, upper and lower end fittings, hold-down springs, end box assembly, intermediate grid and slip mechanism, fuel rods and the outer thin box shell, are idealized into a planar two-dimensional multi-degree of freedom lumped mass system using finite element method. Included in the analysis are the adverse effects of non-linearities due to gapped springs and interaction between adjacent impacting assemblies. In order to completely assess the adequacy of each fuel assembly system, the overall effects of both seismic as well as LOCA are evaluated and superimposed directly. To account for various non-linearities due to gapped springs, columb friction, impact loads, sliding and hydrodynamic effects, the modified computer code 'IN-TRANS' has been utilized, which considers numerical integration solution of non-linear transient dynamic analysis of seismic and LOCA conditions, using known time-history loads. The numerical results have shown that the maximum stress resultants on the fuel assembly due to combined effects of both seismic and LOCA load excitations are well below the allowable limits and the maximum deflection levels are assessed to be lower than the critical values that could prevent the insertion of control rods or the flow of coolant through the gapped tolerances in core assembly.

50095 (INIS-mf—4498, pp v) **Dynamic analysis of fuel elements in boiling water reactor.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Antiseismic design of Boiling Water Reactor core is one of the most important parts of BWR nuclear power plant design. The range of the natural frequency of the fuel assemblies is similar to that of the natural frequency of the reactor building and the predominant frequency of the earthquake. It is very difficult to investigate the dynamic behavior of the reactor core, because the core consists of many fuel assemblies and is in water. The difficulty mainly depends upon the fact that the reactor core is not only considered as the multidegrees of freedom system, but also the interaction between the water and the fuel assemblies must also be taken into consideration. Fuel assemblies are allocated in the circular shape shroud in actual design. The circular form of the shroud and the core arrangement were replaced by the square form. Assuming the flow of the water is two-dimensional, the fluid force was obtained on the fuel assemblies by applying potential theory. The dynamic equations of the fuel assemblies are obtained by using these external hydraulic forces. If the core consists of n x n fuel assemblies, we must make 2n x n equations and these can be represented by a matrix equation. These equations were solved numerically. On the other hand, a core model was planned for testing in which the number of fuel assembly models can be changed. A tank in which 21 fuel assembly models on the scale of about a quarter are set in a rectangular lattice shape is placed on the shaking table and vibrated.

50096 (KFK—2623) **Comparison between a one- and a two-dimensional calculation of a water-vapor nozzle flow.** Kedziur, F.; Moesinger, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Oct 1978. 39p. (In German). U 03/MF A01.

The steady water-vapor flow through a convergent nozzle is simulated with the two-phase computer codes DRIX-2D (two-dimensional, transient) and DUESE (one-dimensional, stationary). The results of both codes are compared and interpreted under consideration of their different modeling, especially with respect to the dimensionality and the time-behaviour. In a similar way the one- und two-dimensional calculations of the code STRUYA are compared, which is applied to an ideal gas flow through the HENRY-nozzle. In addition an illustrative, analytical model is developed, which under certain assumptions, determines the difference in the pressure drop between one- and two-dimensional calculation of a nozzle-flow. The main result of these comparisons is the understanding, that in principle the two-dimensional calculation renders a larger pressure-drop of the nozzle-flow than the one-dimensional one. (orig.) 891 GL.

50097 (KFK-EXT—8/78-5) **Assessment of structural dynamics problems in nuclear reactor safety.** Liebe, R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Oct 1978. 56p. (In German). U 04/MF A01.

The paper discusses important physical features of structural dynamics problems in reactor safety. First a general characterization is given of the following problems: Containment deformation due to pool-dynamics during BWR-blowdown; behavior of the core internals due to PWR-blowdown loads; dynamic response of a nuclear power plant during an earthquake; fuel element deformation due to local pressure pulses in an LMFBR core. Several criterias are formulated to classify typical problems so that a better choise can be made both of appropriate mathematical/numerical as well as experimental techniques. The degree of physical coupling between structural dynamics and fluid dynamics is discussed in more detail since it requires particular attention when selecting problem-oriented methods of solution. Some examples are given to illustrate the application and to compare advantages and disadvantages of several numerical methods. Then description is given of experimental techniques in structural dynamics and typical problem areas are identified. Finally some results are presented concerning the fuel element deformation problem in LMFBRs and from the general considerations some important conclusions are summarized. (orig.) 891 RW 892 AP.

50098 (LA-UR—79-1956) **Role of similitude in the design of LMFBR safety-related simulation experiments.** Chapyak, E.J.; Star-

kovich, V.S. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. (CONF-790816—15). P 02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

In this paper we examine the implications of scaling in the design of simulation experiments for two major areas of fast reactor safety research - the transition phase and postdisassembly energetics. Specific scaling requirements and compatible experimental designs are formulated and compared with ongoing programs having similar objectives. Suggestions are also outlined for future out-of-pile experimental research.

50099 (NRL-MR—4006) **Effects of weathering on impregnated charcoal performance.** Deitz,V.R. (Naval Research Lab., Washington, DC (USA)). 10 May 1979. 77p. (NUREG/CR—0771). NTIS, PC A05/MF A01.

The useful life of activated carbon filters in engineered-safety-feature and normal ventilation systems of nuclear power stations is slowly impaired by the contaminants accumulated from the large volume of air being processed. The weathering of eight commercial impregnated activated carbons has now been studied by a two-fold approach: (1) Exposure to unmodified outdoor air for periods up to nine months, followed by measurements of the methyl iodide-131 penetration, and (2) exposure of the same type charcoals to air flows of known pollutant species and concentrations under controlled laboratory conditions, also followed by measurements of the methyl iodide-131 penetration. The influence of moisture in laboratory air flows of 50, 70, and 90% RH has been studied in detail for the eight charcoals. The exposures of the charcoals to outdoor air have now been extended to nine months and the results show a progressive decrease in iodine trapping efficiency. There is evidence from both the laboratory and outdoor exposure tests that moisture can enhance charcoal degradation. An adverse synergistic influence of moisture and hydrocarbon vapors has also been observed. All samples were layered to permit a determination of the profile in properties along the line of flow. The entrance layer, first of four equal layers, was found to be the most significantly affected by the exposure insult. It is believed that local meteorological conditions of high humidity combined with atmospheric pollutants in the test vicinity contribute jointly to the degradation of impregnated activated carbons.

50100 (NUREG/CR—0500) **Assessment of fuel melting, radial extrusion, and cladding thermal failure during a power-cooling-mismatch event in light water reactors.** El-Genk, M.S. (Idaho National Engineering Lab., Idaho Falls (USA)). May 1979. Contract EY-76-C-07-1570. 73p. (TREE—1270). P 04/MF A01.

The thermal behavior of the fuel and the cladding during off-normal operating conditions in light water reactors (LWRs) are of great importance to reactor safety evaluation. In the present work, fuel conditions during a hypothesized power-cooling-mismatch (PCM) accident in LWRs are characterized with regard to pellet cracking and fuel melting. Melting of UO_2 fuel at the center of the pellet during a PCM accident in which film boiling is present at the cladding surface, is assessed by employing a simplified steady state analysis. The induced pressure at the center of the pellet due to fuel melting, fission gas release, and UO_2 fuel vapor may force molten fuel to penetrate through radially open cracks in the outer unmelted portion of the pellet and relocate in the fuel-cladding gap. The contact of molten fuel with Zircaloy cladding, which is at high temperatures during film boiling, may initiate cladding melting at its inside surface and eventually result in a thermal failure of the cladding. An analytical model is developed to study the transient freezing of a superheated liquid penetrating an initally empty crack, maintained at a constant, subfreezing temperature.

50101 (NUREG/CR—0626) **SOLA-LOOP: a nonequilibrium, drift-flux code for two-phase flow in networks.** Hirt, C.W.; Oliphant, T.A.; Rivard, W.C.; Romero, N.C.; Torrey, M.D. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 91p. (LA—7659). P 05/MF A01.

A new, highly flexible computer code for transient, nonequilibrium, two-phase flow in networks is described. Each component may have a one-dimensional representation with a variable cross-sectional area. The flow dynamics is governed by a set of nonlinear conservation laws based on a generalized drift-flux model for two-phase mixtures. The equations are solved by a partially implicit method that can use different time steps in different components. In addition to being simple and modular, the code can use almost any set of constitutive relations, property tables, or other special purpose features required for different applications. An example problem is provided to verify proper implementation of the code on the user's system. It illustrates the automatic treatment of such phenomena as critical two-phase flow without introducing special assumptions and the use of various input options to initiate a pipe break.

50102 (NUREG/CR—0690) **SOLA-DF: a solution algorithm for nonequilibrium two-phase flow.** Hirt, C.W.; Romero, N.C.; Torrey, M.D.; Travis, J.R. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 90p. (LA—7725-MS). P 05/MF A01.

A numerical solution algorithm, SOLA-DF, is presented for the solution of gas-liquid mixture dynamics in two space dimensions and time. The two-phase system is described by a set of mixture equations plus a relation describing the relative flow of one phase with respect to the other. In addition, the algorithm contains models to represent the interphase exchange rates of mass, momentum, and energy for water—steam mixtures.

50103 (NUREG/CR—0752) **LMFBR aerosol release and transport program. Quarterly progress report, October—December 1978.** Kress, T.S.; Tobias, M.L. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 45p. (ORNL/NUREG/TM—318). P 03/MF A01.

This report summarizes progress for the Liquid-Metal Fast Breeder Reactor (LMFBR) Aerosol Release and Transport (ART) Program sponsored by the Division of Reactor Safety Research of the Nuclear Regulatory Commission (NRC) for the period October—December 1978. This program is designed to investigate radionuclide release and transport from LMFBRs for reactor events of severity up to and including hypothetical core-disruptive accidents (HCDAs). Program topics discussed include recent capacitor discharge vaporization (CDV) tests in the Fuel Aerosol Simulant Test (FAST)/Containment Research Installation (CRI-III) facility, including underwater and argon tests in the CRI-III vessel; sodium spray fire experiments in the Nuclear Safety Pilot Plant (NSPP); results from U_3O_8 aerosol tests in CRI-II using the dc plasma metal—oxygen torch, and development and testing of the dc plasma metal—oxygen torch for NSPP; and a parametric study of heat and mass transfer mechanisms for a UO_2 bubble rising in sodium.

50104 (NUREG/CR—0828) **Light-Water-Reactor Safety Research Program. Quarterly progress report, October—December 1978.** (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 46p. (ANL—79-18). P 03/MF A01.

This progress report summarizes the Argonne National Laboratory work performed during October, November, and December 1978 on water-reactor-safety problems. The following research and development areas are covered: (1) Loss-of-coolant Accident Research: Heat Transfer and Fluid Dynamics; (2) Transient Fuel Response and Fission-product Release Program; and (3) Mechanical Properties of Zircaloy Containing Oxygen.

50105 (NUREG/CR—0832) **INCAP: a finite element program for one-dimensional nonlinear inverse heat conduction analysis.** Bass, B.R. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 95p. (ORNL/NUREG/CSD/TM—8). Dep. NTIS, PC E03/MF E03.

The calculation of the surface temperature and surface heat flux from a measured temperature history at an interior point of a body is identified in the literature as the inverse heat conduction problem. This report presents apparently the first application of an inverse solution technique that utilizes a finite element heat conduction model and Beck's nonlinear estimation procedure. The technique is applicable to the one-dimensional nonlinear model with temperature-dependent thermophysical properties. A digital computer program INCAP (INverse Heat Conduction Analysis Program) is developed from the formulation and is used in a comparative study with the finite difference inverse code ORINC (ORNL INverse Code). Specifically, two representative thermocouple transients obtained from electrically heated composite rods during a simulated loss-of-coolant accident are analyzed with INCAP and ORINC and the results are compared.

50106 (NUREG/CR—0844) **LMFBR aerosol release and transport program. Quarterly progress report, January—March 1979.** Kress, T.S.; Han, J.T. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 56p. (ORNL/NUREG/TM—329). P 04/MF A01.

This report summarizes progress for the Liquid-Metal Fast Breeder Reactor (LMFBR) Aerosol Release and Transport (ART) Program sponsored by the Division of Reactor Safety Research of the Nuclear Regulatory Commission (NRC) for the period January—March 1979. This program is designed to investigate radionuclide release and transport from LMFBRs for reactor events of severity up to and including hypothetical core-disruptive accidents (HCDAs). Program topics discussed include recent capacitor discharge vaporization (CDV) tests in the Fuel Aerosol Simulant Test (FAST)/Containment Research Installation (CRI-III) facility, including underwater and vacuum tests in the CRI-III vessel; fuel-oxide tests in the Nuclear Safety Pilot Plant (NSPP) using a newly installed dc plasma metal-oxygen torch; fuel-oxide aerosol size measurements using two different instruments in the CRI-II facility, and calculated results of average size and number of primary particles per aerosol agglomerate; an evaluation of the HAARM-3 code fallout model using NSPP data; and the development of a simple analytical method to estimate the buoyancy-induced air velocity in the NSPP tests.

50107 (QLR-L—3-0) **Quick-look report on LOFT nonnuclear experiment L3-0.** Jarrell, D.B. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1979. Contract EY-76-C-07-1570. 48p. P 03/MF A01.

The preliminary evaluation has been completed of the results from nonnuclear Loss-of-Coolant Experiment (LOCE) L3-0, which was successfully conducted on May 31, 1979, in the Loss-of-Fluid Test (LOFT) facility. LOCE L3-0, the first experiment in the LOFT Small and Intermediate Break Series L3, simulated a small break at the top of the LOFT pressurizer by opening the power operated pressure relief valve. For this experiment, the nuclear core remained installed and in a shutdown condition. The initial conditions and plant configuration were similar to previous nuclear LOCEs performed in experiment Series L2 with the exception of the primary system being isothermal due to the lack of reactor heat input. Selected data, presented in this report, confirm that the objectives of LOCE L3-0 were successfully achieved.

50108 (SAND—79-0621) **Ultrasonic thermometry system for measuring very high temperatures in reactor safety experiments.** Carlson, G.A.; Sullivan, W.H.; Plein, H.G.; Kerley, T.M. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract EY-76-C-04-0789. 83p. P 05/MF A01.

Ultrasonic thermometry has many potential applications in reactor safety experiments, where extremely high temperatures and lack of visual access may preclude the use of conventional diagnostics. This report details ultrasonic thermometry requirements for one such experiment, the molten fuel pool experiment. Sensors, transducers, and signal processing electronics are described in detail. Axial heat transfer in the sensors is modelled and found acceptably small. Measurement errors, calculations of their effect, and ways to minimize them are given. A rotating sensor concept is discussed which holds promise of alleviating sticking problems at high temperature. Applications of ultrasonic thermometry to three in-core experiments are described. In them, five 10-mm-length sensor elements were used to measure axial temperatures in a UO_2 or UO_2-steel system fission-heated to about 2860°C.

50109 (SAND—79-1372C) **Application of SAFE to an operating reactor.** Chapman, L.D. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 26p. (CONF-790707—18). P 03/MF A01.

From 20. annual meeting of the Institute of Nuclear Materials Management; Albuquerque, NM, USA (16 Jul 1979).

A method for the evaluation of physical protection systems at nuclear facilities has been developed. The evaluation process consists of five major phases: (1) Facility Characterization, (2) Facility Representation, (3) Component Performance, (4) Adversary Path Analysis, and (5) Effectiveness Evaluation. Each of these phases will be described in some detail and illustrated by examples. The process for evaluation of physical protection system effectiveness against an outside threat will be presented for a reactor facility.

50110 (TFBP-TR—321) **Power-cooling-mismatch Test PCM-7 experiment predictions.** Smith, R.H.; Sparks, D.T. (Idaho National Engineering Lab., Idaho Falls (USA)). Jun 1979. Contract EY-76-C-07-1570. 47p. P 03/MF A01.

The Test PCM-7 objective is to study the response of PWR type fuel rods subjected to high temperature film boiling operation in a small cluster geometry. To attain this objective, extensive calculations to evaluate the test design and conduct were performed. Some of the analysis were conducted for Test PCM-5 and due to the similarities between Tests PCM-5 and PCM-7, were not repeated. Other calculations were conducted on the basis of posttest results obtained from Test PCM-5 to help evaluate the complex interdependence of the local thermal-hydraulic conditions within the cluster. The computer code calculations and the application of the results are summarized.

50111 (TREE—1329) **NUREG/CR—0618.** Larson, J.R.; Spore, J.W.; McCardell, R.K.; Broughton, J.M.; Sepold, L.K. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1979. Contract EY-76-C-07-1570. 74p. P 04/MF A01.

This report presents the results of Loss-of-Coolant (LOC) Test LOC-11, the first test of the Loss-of-Coolant Accident (LOCA) Test Series conducted by the Thermal Fuels Behavior Program of EG & G Idaho, Inc., in the Power Burst Facility (PBF) at the Idaho National Engineering Laboratory. The primary objective of the test was to evaluate the behavior of pressurized water reactor (PWR) fuel under LOCA conditions similar to those postulated during a simulated double-ended cold leg break in a PWR. Test LOC-11 consisted of four, separately shrouded, fresh fuel rods of PWR design, with initial plenum pressure as a variable. Maximum cladding temperatures of up to 1070°K (corresponding to high ductility α-phase Zircaloy) were sought during Test LOC-11. The fuel rods were exposed to a series of three blowdowns from different power and coolant conditions. The final blowdown resulted in the maximum measured cladding temperature of 1034°K. Upon disassembly of the test train the rods were found to be uniformly covered with a dark grey oxide. Posttest results indicated slight cladding circumferential swelling of the pressurized rods and slight collapse of the relatively unpressurized rods. The results are compared with the posttest analyses to aid in understanding the coolant thermal-hydraulic behavior and fuel rod behavior.

50112 (UCID—18130) **Computer-aided digitization of graphical mass flow data from the 1/5-scale Mark I BWR pressure suppression experiment.** Holman, G.S.; McCauley, E.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jul 1979. Contract W-7405-ENG-38. 20p. P 02/MF A01.

Periodically in the analysis of engineering data, it becomes necessary to use graphical output as the solitary source of accurate numerical data for use in subsequent calculations. Such was our experience in the extended analysis of data from the 1/5-scale Mark I boiling water reactor pressure suppression experiment (PSE). The original numerical results of extensive computer calculations performed at the time of the actual PSE tests and required for the later extended analysis program had not been retained as archival records. We were, therefore, required to recover the previously calculated data, either by a complete recalculation or from available computer graphics records. Time constraints suggested recovery from the graphics records as the more viable approach. This report describes two different approaches to recovery of digital data from graphics records. One, combining hard and software techniques immediately available to us at LLL, proved to be inadequate for our purposes. The other approach required the development of pure software techniques that interfaced with LLL computer graphics to unpack digital coordinate information directly from graphics files. As a result of this effort, we were able to recover the required data with no significant loss in the accuracy of the original calculations.

50113 (UCRL—15052(Vol.1)) **Verifying seismic design of nuclear reactors by testing. Volume 1: test plan.** (Agbabian Associates, El Segundo, CA (USA)). 20 Jul 1979. Contract W-7405-ENG-48. 110p. P 06/MF A01.

This document sets forth recommendations for a verification program to test the ability of operational nuclear power plants to achieve safe shutdown immediately following a safe-shutdown earthquake. The purpose of the study is to develop a program plan to provide assurance by physical demonstration that nuclear power plants are earthquake resistant and to allow nuclear power plant operators to (1) decide whether tests should be conducted on their facilities, (2) specify the tests that should be performed, and (3) estimate the cost of the effort to complete the recommended test program.

50114 (UCRL—15052(Vol.2)) **Verifying seismic design of nuclear reactors by testing. Volume 2: appendix, theoretical discussions.** (Agbabian Associates, El Segundo, CA (USA)). 29 Jul 1979. Contract W-7405-ENG-48. 58p. P 04/MF A01.

Theoretical discussions on seismic design testing are presented under the following appendix headings: system functions, pulse optimization program, system identification, and motion response calculations from inertance measurements of a nuclear power plant.

50115 (DOE-tr—90) **Behaviour of the core of a fast sodium-cooled breeder reactor of 2000 MW(e) during disruptive accidents with a very low likelihood of occurrence.** Struwe, D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Sep 1978. Translation of KFK—2490. 204p. U 10/MF A01.

Work performed under United States—W. Germany Fast Reactor Exchange Program.

A structural phase diagram for hypothetical core disruptive accidents (HCDA) has been developed based on a variety of analyses for different LMFBRs. The intent was to identify the strategic phases of HCDAs which are important with regard to the safety aspects of the plant. These phases are investigated in detail for a 2000 MW(e) LMFBR (SNR-2000). Characteristic data of the SNR-2000 are discussed concerning their effect on safety analysis. Reasons for the choice of model parameters for special phenomena such as fuel-coolant interaction, fuel rod failure mechanisms, and sodium boiling are given. The results of calculations with CAPRI-2, HOPE and KADIS are analyzed for possibilities of entering into energetic core disassembly with consequences which would require power values below 2000 MW(e).

50116 (DOE-tr—40) **Fast Breeder Project. Second quarterly report, 1977.** (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). 31 Aug 1978. Translation of KFK—1277/2, October 1977. 209p. U 10/MF A01.

Work performed under United States—W. Germany Fast Reactor Exchange Program.

Progress is summarized in the areas of fuel rod development, materials studies, reactor kinetics, reactor safety, and cooling system technology.

50117 Computer code SEURBNUK-2 for fast reactor explosion containment safety studies. Cameron, I.G.; Hankin, B.C.; Warham, A.G.P. (Ministry of Defence, Aldermaston (UK). Atomic Weapons Research Establishment); Benuzzi, A.; Yerkess, A. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp 1-12 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper describes the theory and capabilities of the SEURBNUK-2 fluid flow code developed by JRC Ispra and AWRE Aldermaston for use in containment analysis for fast reactor explosion containment studies. It is a 2D Eulerian code and is a major extension of the SURBOUM code developed earlier by Belgonucleaire and Aldermaston. SEURBNUK-2 has a full thin shell treatment for tanks of arbitrary shape and is able to include the effects of compressibility of the fluid. To introduce the effects of comporessibility into the code, viscosity and diffusion are neglected and a purely implicit time centered difference scheme adopted. Results are presented from a SEURBNUK calculation for the Ispra test shot 114 of the expansion of a Belgonucleaire charge in an overstrong water filled vessel. Comparisons are made both with experimental results and with calculations done on the 2D Lagrangian codes REXCO-H and ASTARTE-2.

50118 Hydro-elastic calculations of the dynamic response of a reactor to a sudden loss of coolant. Dienes, J.K.; Hirt, C.W.; Stein, L.R. (Los Alamos Scientific Lab., NM (USA)). pp B1/3 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50119 Calculation of hydrodynamic structural interactions in the subcooled blowdown of a pressurized water reactor. Dumheller, D.S. (Sandia Labs., Albuquerque, NM (USA)). pp B4/2 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50120 Investigation of the structural integrity of the reactor vessel for a postulated core meltdown accident. Gluekler, E.L. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.); Clever, R.M.; Rumble, E.T. (Science Applications, Inc., Palo Alto, CA (USA)). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

If a core meltdown accident is postulated to occur, a large mass of molten fuel and steel debris could collect at the bottom of the reactor vessel. As a consequence, the vessel would be subjected to rapid heating and surface melting. In the absence of adequate cooling, inelastic failure or meltthrough could occur. The two dimensional thermal response of the vessel was obtained from a multireigion ADI solution of the fully implicit finite difference analogues of the governing differential equations. These equations have been transformed into a coordinate system moving with the melting surface. All non-linear effects such as the surface boundary conditions were included using an iterative scheme with quasi-linear equations.

50121 Coupled structure-fluid analysis for a PWR burst protection design. Huber, A.; Hofmann, H. (SDK Ingenieurunternehmen fuer Spezielle Statik, Dynamik und Konstruktion, Loerrach (Germany, F.R.)). pp 1-19 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The burst protection considered is designed to withstand hypothetical ruptures which might occur in certain components of the primary circuit including RPV rupture. It mainly consists of cylindrical concrete vessels for the RPV and the steam generators and steel tubing for the primary pipes. The burst protection structures are placed tight to the primary loop. A hypothetical RPV failure will result in direct excitation of single components and will lead to complex interactions between all components of the protecting structures, the primary loop, reactor core, core support structures and the coolant. The overall investigations to determine the magnitude of deformations and stresses are summarized. Economical aspects with respect to the investigation are treated briefly. The coupled structure-fluid analysis of the core and core support structure due to horizontal and vertical RPV failure are presented in detail. Assumptions for the RPV failure modes are made which are expected to lead to extreme conditions in any part of the system. The assumptions include vertical, horizontal and screw-shaped rupture of the RPV, the detachment of RPV nozzles as well as other types of failure. On the basis of the failure modes, types of credible external load conditions are estimated.

50122 2D fluid flow in the downcomer and dynamic response of the core barrel during PWR blowdown. Katz, F.; Krieg, R.; Ludwig, A.; Schlechtendahl, E.G.; Stoelting, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 1-10 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

As a part of the HDR program, methods for coupled fluid/structure dynamics are being developed. On the fluid side the 2D finite difference code YAQUI has been modified and adapted to describe the fluid dynamics in the downcomer of PWR's. On the structural side for determination of the dynamic core barrel response the code CYLDY2 has been developed. In this code the core barrel is treated as a thin cylindrical shell fixed at the upper end and ring stiffened at the lower end. The mass of the lower end ring also simulates a part of the core mass. Both models have been successfully tested. Coupling has been achieved for a simplified structural model proving the correctness of the coupling procedure. YAQUIR is a significantly modified version of the code YAQUI. The coupling of YAQUIR and CYLDY2 is performed by imbedding the structural model in the fluid model. Fluid velocities are parellel to the fluid/structure interface. The structure displacements define the time and space dependent thickness of the two-dimensional fluid layer. While coupling of the complete CYLDY2 model with YAQUIR is still underway, results have been obtained with a simple axisymmetric structural model. For an axisymmetric test case three forms of pressure fluctuations have been observed: 1) radial oscillations dominated by the local compressibility of the water, 2) axial compression/expansion waves in the water considerably different from those obtained for a rigid barrel, 3) bulk axial water oscillations dominated by the global compressibility of the core barrel.

50123 Full-scale HDR blowdown experiments as a tool for investigating dynamic fluid-structural coupling. Krieg, R.; Schlechtendahl, E.G.; Scholl, K.H.; Schumann, U. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 1-11 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

As an answer to rigorous safety requirements in reactor technology an experimental-theoretical program has been established to investigate safety-relevant mechanical aspects of LWR-blowdown accidents. Part of the program are several full-scale blowdown experiments which will be performed in the former HDR-reactor. As the conceptional study confirms, the primary goal is to find out, how big the safety margins of present LWR's in the case of a blowdown actually are, rather than simply to show that essential parts of the reactor will withstand such an accident. However, to determine the safety margins, the physical phenomena involved in the blowdown process must be understood and appropriate wave of description must be found. Therefore the experimental program is accompanied by the development of theoretical models and computer codes. A survey is given over existing methods for coupled fluid structural dynamics. The following approaches are used: - Specific finite difference-code for integrated treatment of both fluid and structure in 3D-geometry using the fast cyclic reduction scheme for solving Poisson's equation. - Modification of mass and stiffness matrices of FEM-models for shell dynamics by reducing the 3D incompressible fluid problem to 2D with the boundary integral equation method. This presently developed method has the capacity to deal with general problems in fluid-structural coupling.

50124 Damping of the radial impulsive motion of LMFBR core components separated by fluid squeeze films. Liebe, R.; Zehlein, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). pp 1-12 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The core deformation of a liquid metal cooled fast breeder reactor (LMFBR) due to local pressure propagation from rapid energy releases is a complex three-dimensional fluid-structure-interaction problem. High pressure transients of short duration cause structural deformation of the closely spaced fuel elements, which are surrounded by the flowing coolant. Corresponding relative displacements give rise to squeezing fluid motion in the thin layers between the subassemblies. Therefore significant backpressures are produced and the resulting time and space dependent fluid forces are acting on

the structure as additional non-conservative external loads. Realistic LMFBR safety analysis of several clustered fuel elements have to account for such flow induced forces. Several idealized models have been proposed to study some aspects of the complex problem. As part of the core mechanics activities at GfK Karlsruhe this paper describes two fluid flow models (model A, model B), which are shown to be suitable for physically coupled fluid-structure analyses. Important assumptions are discussed in both cases and basic equations are derived for one- and two-dimensional incompressible flow fields. The interface of corresponing computer codes FLUF (model A) and FLOWAX (model B) with structural dynamics programs is outlined. Finally fluid-structure interaction problems relevant to LMFBR design are analyzed; parametric studies indicate a significant cushioning effect, energy dissipation and a strongly nonlinear as well as timedependent damping of the structural response.

50125 Vertical forces induced in a 1/5 scale Mark I BWR toroidal wetwell under LOCA conditions. Pitts, J.H.; McCauley, E.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp B4/6 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50126 Fracture mechanics method of evaluating structural integrity of a reactor vessel due to thermal shock effects following LOCA condition. Ramani, D.T. (Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland)). pp 1-15 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The importance of knowledge of structural integrity of a reactor vessel due to thermal shock effects, is related to safety and operational requirements in assessing the adequacy and flawless functioing of the nuclear power systems. Following a loss-of-coolant accident (LOCA) condition the integrity of the reactor vessel due to a sudden thermal shock induced by actuation of emergency core cooling system (ECCS), must be maintained to ensure safe and orderly shutdown of the reactor and its components. The paper encompasses criteria underlaying a fracture mechanics method of analysis to evaluate structural integrity of a typical 950 MWe PWR vessel as a result of very drastic changes in thermal and mechanical stress levels in the reactor vessel wall. The main object of this investigation therefore consists in assessing the capability of a PWR vessel to withstand the most critical thermal shock without inpairing its ability to conserve vital coolant owing to probable crack propagation.

50127 Lagrangian and Eulerian finite element techniques for transient fluid-structure interaction problems. Donea, J.; Fasoli-Stella, P.; Giuliani, S. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). pp 1-12 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper is concerned with the description of a finite element method developed for the nonlinear transient response of coupled hydrodynamics-structures problems such as encountered in the safety analysis of nuclear reactor components. The basic finite element equations for transient compressible fluid flow are presented in a form that allows the elements to be moved with the fluid in normal Lagrangian fashion, to be held fixed in a Eulerian manner, or to be moved in some arbitrarily specified way. The co-existence of Lagrangian and Eulerian regions within the finite element mesh will permit to handle greater distortions in the fluid motion than would be allowed by a purely Lagrangian method, with more resolution than is afforded by a purely Eulerian method. To achieve a mixed formulation, the conservation statements of mass, momentum and energy are expressed in integral form over a reference volume whose surface may be moving with an arbitrarily prescribed velocity. The hydrodynamic elements presented are triangles, quadrilaterals with constant pressure and density. The finite element equations associated with these elements are described in the necessary detail. Numerical results are presented based on purely Lagrangian, purely Eulerian and mixed formulations. Simple problems with analytic solution are solved first to show the validity and accuracy of the proposed mixed finite element formulation. Then, practical problems are illustrated in the field of fast reactor safety analysis.

50128 Improved coupled Euler-Lagrange finite element analysis of the fluid-structure dynamic interaction problem. Dubois, J.J.; de Rouvray, A.L. (Engineering System International S.A., 20 Rue Saarinen, F-94150 Rungis Silic, France). pp 1-8 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Improved formulation are presented for the Finite Element Analysis of the linearized coupled structure-fluid with free surface, interaction problem, during earthquake or flow induced vibrations. Eulerian coordinates are used for the comporessible or incompressible fluid, and Lagrangian coordinates for the shell/solid containment and free surface waves. Assuming small displacements in the fluid, modes shapes and frequencies of the coupled system are obtained. The improvements reside in a systematic way of removing zero frequency modes by Lagrange multipliers, and the treatment of free surface waves in Lagrangian coordinates, resulting in a symmetric matrix equation system solvable with standard structural finite element programs. Examples are presented with PAM-AX3D, a finite program for axisymmetric geometries and Fourier decomposition of non-axisymmetric earthquake loads.

50129 Novel technique for calculating fluiddynamic phenomena with respect to structural feedback. Grillenberger, T.; Oesterle, B. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching (Germany, F.R.)). pp 1-10 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977). (In German)

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The investigation of strongly transient fluid dynamic phenomena requires a consideration of flexible walls. This occurs particularly in nuclear power plant safety problems, e.g. in the field of blowdown simulations. The reasons for considering flexible walls are: - Very high pressure loads may appear. The related structural displacements have the order of magnitude of the fluid compressibility and therefore influence the fluid variables. - The frequency of the pressure loads may lie in the range of the structural eigenfrequencies. For the solution of the problems outlined above a method is proposed which uses two separate codes, one for the structure and one for the fluid. Thus, the advantages of both methods, which may base on completely different methods can be inserted into the calculation. On the one hand a finite element structural code is used, on the other hand a one-dimensional flow model (including pressure wave and thermodynamic non-equilibrium effects) is utilized, which is also applicable for a calculation of two- and three-dimensional fluid problems by introducing a mesh of one-dimensional fluid channels. The fluiddynamic part of the realized code consists mainly of the code DAPSY, which is a further development of the code BLAST. The setting up of the partial differential equations is performed in Eulerian coordinates and the integration is accomplished by the method of characteristics.

50130 Fluid-structure interaction calculations. Gross, M.B.; Hofmann, R. (Science Applications, Inc., Oakland, CA (USA)). pp B1/5 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50131 Finite-element analysis of two-phase flows. Hatt, F.; Marcal, P.V. (MARC Analysis Research Corp., Palo Alto, CA (USA)). pp 1-9 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Safety studies for liquid cooled reactors address the questions raised by postulated failures on the cooling system. It is of importance to predict the time history of the depresurization that follows a loss of coolant accident to guarantee the integrity of the overall system. In this report the sudden depressurization of a straight pipe filled with heated and compressed water is investigated. This condition is isolated from a complicated sequence of events triggered by a loss of coolant in a water cooled reactor. The investigated water column contained in a straight section of pipe is released suddenly at one end. After a quick initial pressure drop, vaporization occurs. At this point, the rate of depressurization becomes much lower. The pressure inside the pipe is now controlled by the rate at which the steamwater mixture escapes through the open end. Previous analytical investigations used the fluid dynamics equations for conservation of mass, momentum and equilibrium. The resulting differential equations in time were solved by means of finite-difference operators. This investigation represents the first attempt to employ a direct stiffness finite-element approach to the solution of the depressurization of a straight pipe. The MARC Nonlinear Finite Element Analysis program provided the necessary software capabilities.

50132 Transient cavitation effects in fluid piping systems. Kot, C.A.; Youngdahl, C.K. (Argonne National Lab., IL (USA)). pp B2/6 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50133 Fluid-solid interaction by finite element techniques. Wertheimer, T.B.; Marcal, P.V. (MARC Analysis Research Corp., Palo Alto, CA (USA)). pp 1/4 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50134 Dynamic analysis of multibody system immersed in a fluid medium. Wu, R.W.; Liu, L.K.; Levy, S. (General Electric Co., San Jose, CA (USA). Nuclear Energy Systems Div.). pp 1-14 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper is concerned primarily with the development and evaluation of an analysis method for the reponse prediction of immersed systems to seismic and other dynamic excitations. For immersed multibody systems, the hydrodynamic interaction causes coupled motion among the solid bodies. Also, under intense external excitations, impact between bodies may occur. The complex character of such systems inhibit the use of conventional analytical solutions in closed form. Therefore, approximate numerical schemes have been devised. For an incompressible, inviscid fluid, the hydrodynamic forces exerted by the fluid on solid bodies are determined to be linearly proportional to the acceleration of the vibrating solid bodies; i.e., the presence of the fluid only affects the inertia of the solid body system. A finite element computer program has been developed for computing this hydrodynamic (or added) mass effect. This program can be used to determine the hydrodynamic mass of a two-dimensional fluid field with solid bodies of arbitrary geometry. Triangular elements and linear pressure interpolation function are used to discretize the fluid region. The component element method is used to determine the dynamic response of the multibody system to externally applied mechanical loading or support excitation. The present analysis method for predicting the dynamic response of submerged multibody system is quite general and pertains to any number of solid bodies. However in this paper, its application is demonstrated only for 4 and 25 body systems.

50135 Head failure analysis of PCRV's as determined by finite element analysis. Abdulrahman, H.O.; Schnobrich, W.C. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). pp 3/3 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50136 Experimental investigation on the behaviour of pressure suppression containment systems by the SOPRE-1 facility. Cerullo, N.; Delli Gatti, A.; Marinelli, M.; Mazzini, M.; Mazzoni, A.; Sbrana, A.; Todisco, P. (Pisa Univ. (Italy). Ist. di Impianti Nucleari). pp 1-12 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The SOPRE-1 test facility is an integral model (scale 1:13) of a MARK II pressure suppression containment system. It was set up at the University of Pisa in order to study the pressure-temperature transient in pressure suppression containment systems during LOCAs. Knowledge of this transient is necessary to perform a correct structural analysis of reactor containment. The containment system behaviour is studied by changing the principal parameters which affect the transient (blow-down mass and energy release, suppression pool water temperature, vent pipe number and submergence heat transfer coefficients). The first series of tests involved: A) 13 tests with break area of 1.8 cm^2, B) 8 tests with break area of 20.0 cm^2. The following experimental conditions were changed: - position of the simulated break (from liquid or steam zone), - water pressure (20-85 Kgsub(p)/cm^2) and mass (45-70Kg) in the vessel model. Tests A): the CONTEMPT codes correctly forecast the pressure-temperature history, both in dry- and in wet-well. Tests B): the experimental runs have shown that increasing of blow-down flowrate produces dry-well pressure spatial differences and anomalous vent pipe behaviour. This results in damped oscillations of dry- and wet-well pressure, probably due to alterbating air bubble over-expansion and collapse, and in vent pipe opening and reclosing.

50137 Analysis of vessels' supporting skirts for shear transmitted by bearing. Elgaaly, M.; Tuveson, G.A. (Bechtel Power Corporation P.O. Box 1000, Ann Arbor, Michigan 48106, U.S.A.). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Vertical vessels are sometimes supported by means of suitable structure resting on a reinforced concrete foundation (pedestal). This support structure between the vessel and the foundation may consist of an integral (or welded to the vessel) cylindrical shell termed a 'skirt'. Reactor pressure vessels or Steam Generators can be subjected to very high lateral external loads during a seismic event or due to a loss of coolant (LOCA). These loads have to be transmitted to the foundation via the skirt. One way of transmitting the applied shear load is by direct bearing between the skirt bearing flange and a ring bumper around and in contact with the skirt flange and securely attached to the concrete foundation. Due to this mode of shear load transfer the skirt bearing flange and part of the shell in its vicinity will be subjected to stresses which need to be evaluated. A model has been devised in which the bumper was idealized as a set of linear springs which can take only compressive loads. The problem was solved by iteration, where convergence was quick and uniform.

50138 New approach to suppression pool hydrodynamics. Liang, S.S.; Luk, C.H. (Stone and Webster Engineering Corp., Boston, MA (USA)). pp B5/5 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50139 (COO—4261-9) **Effect of overlaying steel layers on the growth of molten core debris pools in concrete.** Paik, I.K.; Felde, D.K.; Abdel-Khalik, S.I. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). [nd]. Contract EN-77-S-02-4261. 5p. P 02/MF A01.

Following a hypothetical core disruptive accident (HCDA) in a fast reactor, the core debris may be in the form of a molten pool which is volumetrically heated by the radioactive decay of the dissolved fission products. The debris pool may be retained in the concrete support structure below the reactor vessel. It grows continually by melting the concrete which readily dissolves in the pool. The purpose of this research is to simulate the heat and mass transfer processes taking place in the molten steel/core debris/concrete system. The effects of the initially-lighter steel layer atop the pool and the subsequent inversion process on the transient radial and downward growth rates of the pool are investigated.

50140 (COO—4261-10) **Retention of molten core debris pools in composite sacrificial beds.** Paik, I.K.; Abdel-Khalik, S.I. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). [nd]. Contract EN-77-S-02-4261. 5p. P 02/MF A01.

Passive core catchers have been proposed as a means for retaining the core debris following a hypothetical core disruptive accident in a fast reactor. The core debris which may be in the form of a molten pool is passively retained in a sacrificial bed of high melting temperature material placed inside or outside the reactor vessel. Recently, it has been suggested that composite sacrificial beds with a low-melting-temperature zone inside the main high-melting-temperature bed may be more effective in retaining the pool than simple beds. It was argued that the inner zone would quickly melt and dilute the pool so that further growth into the main bed would be slowed. Hence, the main objective of this work has been to examine the composite bed concept to ascertain its efficacy vis-a-vis simple sacrificial beds.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 50291, 50293

50141 Evaluated physical properties data for materials used in energy storage systems. Hampel, V.E. (Lawrence Livermore Lab., CA); Gevantman, L.H. *CODATA Bull.;* 6-18(Mar 1979).

Accurate material properties data in support of R. D. and D in energy storage are a prerequisite for cost-effective system designs. This requirement in a relatively old field has been given renewed emphasis since 1976. It has led to a unique arrangement for data evaluation and dissemination wherein the Data Management Group at the Lawrence Livermore Laboratory (LLL), under contract to the Division of Energy Storage Systems of the U.S. DOE identifies materials and properties data required for batteries, flywheels, and for thermal and chemical systems. The users of these data set priorities in which the evaluations are to be carried out. Requests for such evaluations are then forwarded to the Office of Standard Reference Data (OSRD) of the National Bureau of Standards which selects and engages the established network of data centers and other identified sources of expertise. In addition, OSRD manages and monitors the output of the data evaluations prior to their being

published as part of a special NSRDS series of Physical Properties Data Compilations Relevant to Energy Storage, and prior to their being stored on a PDP-11/70 mini-computer for subsequent access by users through the Integrated Information System (IIS) at LLL. As a consequence, administrators, researchers, engineers, and DOE contractors can now access the physical properties in a selective, concise, and up-to-date manner by telephone dial-up and over the ARPAnet computer network from remote terminals, nationwide.This collaborative effort has proven useful and productive. It is hoped it may serve as a prototype, providing impetus for growth of a systematic and timely activity in support of the national energy program. 16 references.

THERMAL

50142 (ORNL/TM—6934) **Low-temperature thermal energy storage program annual operating plan.** Eissenberg, D.M.; Hoffman, H.W. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 68p. P 04/MF A01.

The Low-Temperature Thermal Energy Storage (LTTES) Program operating plans for FY 1979 are described in terms of general program objectives and the technical activities being implemented to achieve these objectives. The program structure provides emphasis on several principal thrusts; namely, seasonal thermal storage, daily/short-term thermal storage, and recovery and reuse of waste heat. Fiscal data are summarized according to thrust area, individual efforts, and funding source.

CHEMICAL

50143 (BNL—50924) **Hydrogen—halogen energy storage system. Annual report, January—December 1977.** McBreen, J.; Srinivasan, S.; Salzano, F.J.; Beaufrere, A.H. (Brookhaven National Lab., Upton, NY (USA)). Sep 1978. Contract EY-76-C-02-0016. 60p. P 04/MF A01.

Work at Brookhaven National Laboratory on the electrochemically regenerative hydrogen—chlorine energy storage system has included electrochemical investigations, materials studies, and technoeconomic assessment. Electrochemical studies have confirmed the reversibility of the cell reactions and the possibility of using the same cell in the electrolysis and fuel cell mode. The hydrogen—chlorine cell differs from most batteries in that the open circuit potential varies appreciably with temperature and depth of discharge. The temperature variation of the open circuit potential reflects the large negative entropy of formation of HCl. A detailed heat and mass balance analysis has been carried out for the H_2/Cl_2 system for one method of reactant storage and two schemes of heat exchange between the hydrochloric acid storage subsystem and the reactant storage subsystems. Characterization of Nafion membranes in H_2/Cl_2 cells is reported. From a cost comparison on a 20 MW/200 MWh electrochemically regenerative hydrogen—halogen system it was concluded that the use of either clorine or bromine or alternative methods of chlorine storage had an insignificant effect on the overall cost of the system. The most cost effective method of hydrogen storage is very dependent on the cost of activated metal hydrides.

BATTERIES

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 49644, 49646

PERFORMANCE AND TESTING

50144 Potentiodynamic behavior of nickel in potassium hydroxide solutions. Schrebler Guzman, R.S.; Vilche, J.R.; Arvia, A.J. (Instituto de Investigaciones Fisicoquimicas Teoricas y Aplicadas, La Plata, Argentina). *J. Appl. Electrochem.;* **8**: No. 1, 67-70(Jan 1978).

The potentiodynamic behavior of Ni in alkaline solutions has been extensively studied with reference to nickel/alkaline galvanic cells. The mechanisms of the electrochemical processes, however, are not yet well established, particularly those relating to the early stages of the film formation process. It is found here that processes involved within that potential region when the solid phase formed at the metal surface is of the order of a few layers thickness are more complex than had been thought. E—I recordings indicate a drastic change of the nature of the electrode surface during partial excursions. Processes occurring at the metal/solution interface involve at least three surface compounds having probably the same stoichiometry but different reactivities. 3 figures. (RWR)

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 50144

50145 (COO—5162-5) **Fabrication and characterization of NASICON ceramic electrolytes. Monthly technical progress report, February 1—February 28, 1979.** Gordon, R.S. (Ceramatic, Inc., Salt Lake City, UT (USA)). 28 Feb 1979. Contract EC-78-C-01-5162. 20p. P 02/MF A01.

Additional samples of NASICON formed from mechanically mixed powders were formed and sintered to adequate mass density. For such mechanical mixtures, sintered densities were determined as a function of sintering temperature and time. In these studies, particle size distributions were measured to ensure relatively constant powder characteristics. A few preliminary closed one end tubes of polycrystalline NASICON were fabricated, but they have not passed the Ceramatec quality control specifications. NASICON samples are now being tested in a static sodium bath at 400°C. In addition, negotiations with Ford Aerospace and Communications Corporation and the General Electric Research and Development Laboratory were completed to set the size of tubes to be delivered for the testing of NASICON electrolyte tubes in sodium—sulfur cells. 11 figures, 4 tables.

50146 Non-linear electric analogs of the current distribution in porous electrodes. Euler, K.J. (Arbeitsgurppe Technische Physik der Gesamthochschule, Kassel, Germany); Seim, B. *J. Appl. Electrochem.;* **8**: No. 1, 49-59(Jan 1978).

Porous battery electrodes can, with respect to their volumetric current distribution, be regarded as electrical networks: linear, time-independent networks again can be treated by analytical methods. In some practical cases, however, deviations have to be considered: non-linear overvoltage functions, changing conductivities. Current distribution in such non-linear and time-dependent systems can be evaluated either by numerical computer calculations, or by the application of corresponding electrical analogs. The latter way is fairly simple and is discussed here. The observed overvoltage functions can be generated by semiconducting diodes. Changing conductivities are generated by adjustable resistors. Application of special automatic devices, e.g. diaphragms with closing pores, seems possible but has not been effected so far. Voltage and current scales have to be adapted to the characteristics of the electronic components. In general, in some practical electrodes the real overvoltage functions may change the current distribution markedly. Particular shoulders in the distribution curves are observed, which ameliorate the electrode utilization. Introduction of measured ionic conductivity changes certainly influences the current distribution, but results in deteriorations of the predicted electrode characteristics. 8 figures, 4 tables.

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 50278

50147 (LA-UR—79-1599) **Energy planning with solar and conservation: individual values and community choice.** Noll, S.A.; Roach, F.; Palmiter, L. (Los Alamos Scientific Lab., NM (USA); National Center for Appropriate Technology, Butte, MT (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790541—24). P 02/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Conflict among the priorities of individuals, private sector businesses, and government entities makes the transition to a renewable energy-resource base a difficult one. These conflicts are intensified by the overwhelming number of externalities created by the actions of each of these decision making groups. This paper explores the nature of some of these conflicts and externalities and gives an illustrative example of the benefits to be derived from community energy planning. Community energy programs have the potential to stimulate household and community income, create job opportunities, develop a more resilient energy economy, and help mitigate environmental deterioration.

50148 (NP—23848) **Organization of the state energy office: selected approaches.** (National Governors' Association, Washington, DC (USA)). Feb 1979. 45p. Q 03/MF A01.

The Committee on Natural Resources and Environmental Management receives many requests on how various states organize, finance, and operate their state energy offices. This publication contains five papers prepared by state energy officials describing their energy programs as they functioned in December, 1978. The state energy officials presenting papers are Vincent DiCara (Maine); John P. Millhone (Minnesota); J.W. Abbott (Missouri); Brian M. Flattery (North Carolina); and Edward J. Spitzer and Jack A. Thomas (Tennessee). (MCW)

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 50152, 50158, 50210, 50219, 50220, 50221, 50235, 50236, 50268, 50915

50149 (DOE/EIA—0183/7) **Review and application of MULTIREGION as a regional economic impact and projection model. Technical report TR/IA/79-26.** Sandoval, A.D. (Department of Energy, Washington, DC (USA). Energy Information Administration). May 1979. 54p. P 04/MF A01.

The report provides an overview of the MULTIREGION model and its use to determine the regional economic implications of three energy and economic projections developed for use in the EIA's 1977 Annual Report to Congress. The MULTIREGION projections are compared with similar projections undertaken using the Regional Earnings Impact System (REIS), developed and maintained by EIA. The strengths and weaknesses of the two modeling systems are reviewed. Examples of the MULTIREGION projection output are presented in an appendix. (MCW)

50150 (UCRL—52672) **Lawrence Livermore Laboratory energy policy model: a brief overview.** Anderson, C.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Mar 1979. Contract W-7405-ENG-48. 12p. P 02/MF A01.

A computer language and model, used to calculate potential patterns of energy production and pricing in the United States, has recently been developed at the Lawrence Livermore Laboratory (LLL). This computer tool is unique in two major respects: (a) it can handle nonequilibrium effects (such as government regulations) within the framework of a general equilibrium network model (i.e., a model of a free-market economy); (b) it is structured in terms of a new symbolic language that greatly facilitates building and experimenting with large models. This report gives a brief overview of the model and language, and provides references to the complete documentation.

50151 (INIS-mf—4499) **Proceedings of the Canadian national energy forum.** (World Energy Conference, Ottawa, Ontario (Canada). Canadian National Committee). [nd]. 14p. (CONF-7704109—). U 02/MF A01.

From Canadian national energy forum; Halifax, Canada (4 Apr 1977).

A separate abstract was prepared for each paper within the scope of the Energy Data Base. (HDR)

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 49599, 49622, 50149, 50150, 50160, 50161, 50164, 50166, 50168, 50199, 50200, 50201, 50202, 50203, 50204, 50205, 50206, 50207, 50213, 50214, 50215, 50216, 50217, 50235, 50240, 50243, 50248, 50249, 50250, 50280, 50288

50152 (BNL—50999) **Modeling market penetration with emphasis on the DFI energy-economy system.** Condap, R.; Kydes, A.S. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). Apr 1979. Contract EY-76-C-02-0016. 60p. P 04/MF A01.

This paper provides a general overview and review of market penetration, the gradual substitution over time of a new commodity for one or more existing commodities in satisfying basic consumption or production needs. The paper then describes, in detail, the market penetration representations of the Decision Focus, Inc. (DFI) modeling system in terms of: (i) its relation to existing representations in the literature; (ii) issues of stability and sensitivity; (iii) issues of parameter measurability; and (iv) its relation to probabilistic interpretations of consumer behavior.

50153 (CONF-7805161—, pp 3.51-3.53) **Methodologies for measuring the social cost of energy subsidies.** Yokell, M.D. (Solar Energy Research Inst., Golden, CO). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Two different methodologies for measuring the social cost of subsidies to the energy industry are briefly outlined. One method relies on price while the other is a cost-based method. In both cases the author outlines those subsidies, transfers, and social costs which are applicable to each method.

50154 (CONF-7805161—, pp 4.24-4.27) **Types of incentives: disbursements.** Doctor, R. (California Energy Resources Development Commission, Sacramento); Esterling, J.; Hinman, G.; Lindberg, L.; Macphee, B.; Sparrow, T. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Workshop participants were divided into groups to discuss specific types of incentives to energy source development. This group focused on an analysis of disbursements as a type of government action. How disbursements have been used by the Federal government in the past and how this type of action might apply to solar were discussed. The dialogue in the group corresponded to a list of questions followed in each of the groups on types of incentives.

50155 (CONF-7805161—, pp 4.32-4.34) **Types of incentives: marketing activity.** Babcock, W. (Booz, Allen, Hamilton, Bethesda, MD); Fassbender, A.; Anderson, R.; Boleyn, D.; Hyman, B. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Market activity is viewed as a major type of government action. Within it, the production of capital goods is the most frequent subtype of government action. This subtype characterizes most activities with the Corps of Engineers, Bureau of Reclamation, Rural Electrification Administration, Tennessee Valley Authority, and Federal power adminstrations. A major question that arose for this discussion group was whether incentives actually stimulated energy production. The question was also raised whether, within certain supply and demand elasticity limits, incentives to consume a particular energy form might have the same effect as incentives to produce that energy form.

50156 (CONF-7805161—, pp 4.35-4.38) **Types of incentives: taxation.** Benveniste, J. (Aerospace Corp., Los Angeles, CA); Sheppard, B.; Sparrow, T.; Savitsky, G.; Taylor, L.; Bezdek, R. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The focus of this discussion group was on taxes specifically related to energy production, not business in general. The group, felt that the major advantages of the tax incentive were self-perpetuating, positive bias toward successful activities, quick response, and private-sector orientation. The disadvantages included conflict with the primary objective of taxation, limitations to quality control, precision of the impact, and counterproductivity with respect to technological innovations. The group made specific recommendations of tax incentives likely to encourage solar energy production.

50157 (CONF-7805161—, pp 5.77-5.79) **Media's role.** Wilson, R. (Times Journal, Condon, OR). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The author characterizes the media as a buffer between the scientist and the science-consuming public. It is felt the media can illustrate the positive and negative repercussions of man's technological advancements. The author illustrates the positive and negative aspects of energy use by using the examples of hydroelectric dams, transportation and large nuclear power plants. If efforts are geared around truth and the longevity of our planet, a collective course will come into focus.

50158 (HCP/I6346—01/1) **Survey of the research into energy-economy interactions. Volume 1. Survey.** Coates, R.; Hanson, D.; Juenger, S.; Kennington, J. (Planco, Inc., Dallas, TX (USA)). Apr 1979. Contract EI-78-C-01-6346. 248p. P 11/MF A01.

Part I of this volume consists of a detailed and comprehensive review of recent (1960 to present) and on-going research into energy-economy interactions. The review focuses on the results fom theoretical and empirical analyses of energy-macroeconomic interactions, the different methodologies used, and the conceptual problems in this research. The review is organized around a number of key energy variables impacting the economy. These variables include the supply of energy, the price of energy, the world price of oil, energy capital requirements, energy R and D, conservation regulations, and stockpiling. Part II begins with a chapter summarizing energy-economy modeling. This chapter provides a conceptual framework for analyzing energy-economy models, discusses the general features and methodologies of a large number of models, and summarizes the state of the art in modeling energy-economy interactions. This survey chapter is followed by detailed reviews of six different energy-economy models: Manne's ETA-MACRO and ETA, Hudson—Jorgenson's LITM, PILOT, Wharton Annual Energy, Reister—Edmonds, and Berkeley (Glassey—Benenson). Each review describes the methodology and general features embodied in the model, summarizes the types of energy-economy interactions addressed, and assesses the capabilities of the model.

50159 (UCID—18037-79-2) **Federal Laboratory Consortium for Technology Transfer. Far West Region Local Government Assistance Task Force. Second progress report.** Miller, C.F.; Sjoholm, A.A. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1979. Contract W-7405-ENG-48. 45p. P 03/MF A01

The Far West Region of the Federal Laboratory Consortium is currently conducting a demonstration project on the needs and problems of local government administrators due to the passage of Proposition 13. This project, the Local Government Assistance Task Force, has been designed to assess the changes in city and county needs resulting from the post-13 budget cuts and to test various methodologies by which the Federal Laboratory Consortium can increase the level of assistance it is providing. The Second Progress Report describes the purposes and goals of the Task Force, the activities that have evolved in support of those goals, and the current status of the specific projects undertaken at the request of administrators in the test jurisdictions, the Cities of San Diego and Berkeley and the County of San Diego. Special emphasis is given to the Energy Link Project and the Stress Disability Retirement Project. The efforts underway in these test sites are expected to be of benefit throughout the nation. New applications of current technology and new methods of transferring technology are being developed here that can be used in other jurisdictions. Periodic reports and presentations are scheduled that will disseminate the results of the Task Force effort.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 49854, 49856, 50169, 50177, 50178, 50179, 50180, 50181, 50182, 50183, 50184, 50185, 50186, 50187, 50188, 50189, 50190, 50191, 50192, 50576, 50599

50160 (CONF-7805161—, pp 4.28-4.30) **Types of incentives: traditional government services.** Koomanoff, F. (Department of Energy, Washington, DC); Brenchley, D.; Hauer, C.; Cone, B. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

This discussion group, discussing the traditional government services, concluded that providing a structure or mechanism for capital formation is one of the most important factors affecting production and use of energy resources. As individuals and corporations do not respond the same way to incentives, and some portion of the solar energy production could come from individuals, members deemed it necessary for the Federal government to tailor traditional government services to specific institutions within the private sector.

50161 (DOE/IA—0002/05) **Joint Egypt/United States report on Egypt/United States cooperative energy assessment. Volume 5 of 5 Vols. Annexes 11—13.** (Department of Energy, Washington, DC (USA)). Apr 1979. 390p. P 17/MF A01.

The principal features of the existing environment of Egypt are characterized and the main problem areas identified in Annex 11. The environmental, health, and associated social issues that must be considered in choosing from among the options available to Egypt for meeting projected future energy needs are identified. The environmental impacts associated with these options are discussed and observations are made of alternte ways to minimize environmental insults. Annex 12, Manpower, analyzes the energy-related manpower situation of Egypt. Manpower education and training resources of Egypt; the existing manpower base of Egypt; manpower needs of the energy strategies; a comparison of manpower needs and existing manpower base; and the underlying economic and social factors that will make Egypt energy facility development very difficult to plan and execute are discussed. Annex 13 summarizes a preliminary analysis of the capital, labor, materials, and equipment resources required to implement alternative Egyptian energy futures and documents the assessment of several Egyptian energy development programs selected by the DOE. It egins with brief overviews of the ESPM model and data base. It then describes the method by which the system was adapted to Egyptian conditions and the results of this modification. The comparison Case energy development program is described, followed by a summary of ESPM-derived facility and resource requirements. Finally, the sensitivity of these results to several alternative energy strategies is illustrated.

50162 (PNL-RAP—36) **Regional issue identification and assessment (RIIA). Volume I. An analysis of the TRENDLONG MID-MID Scenario for Federal Region 10.** Wilfert, G.L.; Beckwith, M.A.; Cowan, C.E.; Keizur, G.R. (comps.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1979. Contract EY-76-C-06-1830. 200p. P 09/MF A01.

Environmental, human health and safety, socioeconomic and institutional impacts of future energy development for Federal Region 10, which includes the states of Alaska, Idaho, Oregon, and Washington, are reported. It is concluded that the reduction in electric generating capacity of 568 MWe specified by the scenario for Alaska will not be realized because of institutional constraints and economic impacts. Development of 1000 MWe of geothermal generating capacity in Region 10 called for by the scenario will not be met by 1990. Besides technical feasibility and economic contraints, procedures in Oregon and Washington for securing leases and siting permits have not been fully developed. The location and impacts associated with construction and operation of oil and gas transshipment facilities such as the proposed pipeline to transport natural gas from fields in northern Alaska to the lower 48 states and the pipeline to transport Alaskan oil through Washington State to refineries in the Midwest are likely to be important issues in the Region. The addition of 7,951 MWe to the currently existing hydroelectric generating capacity of 29,990 MWe by 1990 will intensify competition among multiple uses of limited water resources of the Columbia and Snake River systems which drain Idaho, Oregon, and Washington. Irrigation, recreation, transportation, maintenance of wildlife habitats and anadromous fisheries conflict and compete with hydroelectric power generation. Public opposition to further development of nuclear power currently exists and seems to be intensifying in light of recent events. The scenario-specified addition of 4,816 MWe of nuclear generating capacity to the Region's current nuclear capacity of 2,016 MWe may be jeopardized by this opposition; specifically the 1,174 MWe addition to Oregon's nuclear capacity may not be realized.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 50162, 50194, 50217

50163 (CONF-790727—1) **Systematic method for rapid resource assessment.** Voelker, A.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 15p. P 02/MF A01.

From IIASA-RSI conference on systems aspects of energy and mineral resources; Laxenburg, Austria (9 Jul 1979).

A versatile method was developed to rate the energy- and mineral-resource potentials of areas in which land-management and resource-development decisions must be reached with a minimum expenditure of money and time. The method (1) surveys published and personal information on resources in the region being assessed, (2) selects the most appropriate information, (3) synthesizes the information into map overlays and tract descriptions, (4) rates the potential of tracts for particular resources, (5) rates the overall importance of each tract for resource development, and (6) documents the ratings and their significance. The method was applied to two separate but roughly similar geologic regions. Areas within these regions being considered for possible wilderness designation were rated for their resource potential, and the results were communicated to the appropriate land managers. A comparison of the ratings by this method with ratings produced by other groups demonstrates general agreement but shows this method to be more sensitive than other methods to individual area anomalies.

50164 Growth of limits. Science and technology have continually relieved the limitations on mans ability to live in the circumstances provided by nature. Starr, C. *EPRI J.;* 4: No. 5, 14-17(Jun 1979).

Dr. Starr challenges the factual validity of the assumption that resources are limited. He believes that the resources available for use into the distant future are not generally limited because history testifies that advances in technology expand the availability of resources. Technology does this by providing increased efficiency in the conversion of resources to human uses (that is, less is needed to produce more) and in the extraction of traditional resources from the biosphere, as well as providing methods for the conversion of dormant substances into new resources. So far, we have only extracted a small fraction of the store of the Earth's crust. Dr. Starr cites the example of oil. If oil extraction technology had remained at the 1900 level, we would be out of oil and industry would be at a standstill. He then examines social development in relation to technology advances. He has faith that future generations will competently manage the world they will inherit. (MCW)

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 50234, 50248, 50288

50165 (UCRL—82007) **Commercialization of technology through the Federal Laboratory Consortium for Technology Transfer.** Miller, C.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Dec 1978. Contract W-7405-ENG-48. 8p. (CONF-781216—1). P 02/MF A01.

From ACS symposium series; Miami Beach, FL, USA (12 Dec 1978).

The Federal Laboratory Consortium for Technology Transfer is an active, growing organization of R and D laboratories and centers (about 180) whose members are committed to efforts to

speed the flow of R and D results from the Laboratory to the marketplace. The FLC members seem to function most effectively as brokers, serving as face-to-face contact points between the technology resources and the users. Some successful transfers have taken place, and new approaches to technology transfer and commercialization are being investigated. Examples given of FLC commercialization activities are the tube earphone and microphone unit commercialization; lightweight body armor; spinoff transfer and commercialization of laser technology; program to fully utilize technical information and expertise. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 49864, 49866, 49882, 49945, 49952, 50014, 50015, 50016, 50017

50166 (CONF-7805161—, pp 4.15-4.20) **Energy sources: nuclear incentives.** Hauer, C. (Planning Research Corp., McLean, VA); Harty, H.; Hammerlund, J.; Lindberg, L.; Veigel, J.; Wilson, R.; Yokell, M. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Workshop participants were divided into groups to discuss energy sources and incentives. This group, discussing nuclear incentives, concluded that dollars are not a good measure of incentives, but rather tangible evidence of a will or an intent on the part of the Federal government. Members felt that political factors coupled with the climate of the times were the most important incentives to nuclear power. The nuclear group echoed a concern over the stage of the industry with respect to the effect of incentives. It was felt that the lack of an adequate nuclear waste system was the largest current disincentive to continued growth of the nuclear industry. They felt that without the Price-Anderson Act there would not have been a commercial nuclear industry because no company would have risked a new venture when its entire assets were at stake. After reconvening with the other groups discussing other energy sources, the nuclear group was faced with several questions. The chief area of interest in that discussion was of the political influence exerted by the Joint Committee on Atomic Energy and the Atomic Energy Commission which formed a powerful force and a major incentive to nuclear power. A political, social, institutional framework was created in the relationship between the Congress and Executive under the sanction of the Federal government which may have a close analogy for solar energy.

50167 (INIS-mf—4499, pp 105-115) **Role of conventional energy resources: nuclear.** Foster, J.S. (Atomic Energy of Canada Ltd., Ottawa, Ontario). [nd].

In Proceedings of the Canadian national energy forum. The Canadian energy situation in 1990 and beyond.

A detailed forecast is given of world energy demand and the role nuclear power could play in satisfying this demand, with special attention to the Canadian scene.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 50141

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 49621, 49758, 50241, 50283, 50460

50168 **Energy center: new alternative for effective energy use.** Hemdal, J.F. Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1979). 284p. $27.00.

The primary goal motivating construction and operation of an energy center is to meet the expanding regional demand for electric power generation. Energy centers will be designed to specifications meeting the particular needs of different regions. An energy center will contain, as minimum elements, large electric power generating units, collocated industrial facilities to use the resultant power, and a close cooperation among all units to achieve energy and resource efficiency and conservation. The exact configuration of an energy center will depend on the requirements of a given region, the availability of primary fuels, transportation modes, and environmental as well as social implications. In this book a comparative study is made of energy centers conceived for various locations in the United States, including the following: The Michigan Energy Center; Camp Gruber, Oklahoma, Energy Center; The Commonwealth of Pennsylvania Energy Park; Puerto Rico Energy Center; Wasatch Front Area, Industrial Complex. The goals of a large-scale energy center are economies-of-scale, energy conservation, symbiosis and the concentration of environmental impacts. The benefits of collocation, as opposed to the alternative dispersed sites method, are described in Part One. Energy centers capable of producing 20,000 to 40,000 MWe would provide not only electric power but also process steam and low Btu gas to the collocated industries.

CONSERVATION

REFER ALSO TO CITATION(S) 49491, 50147, 50207, 50211, 50268, 50277, 50281

50169 (DOE/TIC—10691) **Environmental impact determination: submitted to the FEA by the State of Virginia for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 24p. P 02/MF A01.

Virginia's proposed conservation plan was completed. The impact of the Virginia plan, as a whole, will be - if successful - to reduce the state's 1980 energy consumption by 79.84 trillion Btu. This, measured against the 1980 baseline projection for Virginia of 1,587.6 trillion Btu equals a 5.01% savings. These savings, measured across end-use sectors, resulted in an absolute decrease in every environmental residual measured from each fuel consumed in each sector. The five required program measures (state building codes and thermal efficiency standards, lighting standards for public buildings, life-cycle-cost analysis, increase in transit level of transportation systems, right turn on red) account for 21.01 trillion Btu or about 26% of total savings and 58.83 trillion Btu come from additional measures. The plan contains a total of 20 program measures all of which can be grouped into the following: building thermal efficiency, industrial, transportation, lighting efficiency, other. (MCW)

50170 (CONS—0014-T1) **Grant request: to implement energy conservation measures as part of the state original and supplemental energy conservation plans.** (California Energy Resources Conservation and Development Commission, Sacramento (USA). Conservation Div.). 16 Jan 1978. Contract EW-78-G-49-0014. 234p. P 11/MF A01.

Portions of document are illegible.

The program measures described in this document comprise a grant request to DOE under the Energy Policy and Conservation Act of 1975 and the Energy Conservation and Production Act of 1976. The amount requested, $5,555,000, will allow the extension, acceleration, and implementation of energy conservation activities already in progress in California. Accomplishments to date have included the adoption of residential standards, and the implementation of an energy survey program for public buildings. Efficiency standards have been established for refrigerators and room and central air conditioners, appliances which utilize a significant amount of residential energy. Before the end of 1977, efficiency standards will be established for clothes dryers, washers, and water heaters. Program elements are: technical/financial assistance; public awareness; standards setting; solar element; research/analysis/evaluation; and coordination and management.

50171 (DOE/CS—0094) **Report to the Congress on the coordination of Federal energy-conservation programs involving state and local governments.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Jul 1979. 132p. P 07/MF A01.

During the past four years, the Congress has enacted four major laws authorizing the Federal government to develop and implement specific energy-conservation programs. These include the Energy Policy and Conservation Act of 1975 (state energy conservation program); Energy Conservation and Production Act of 1976 (weatherization assistance program); Energy Research and Development Administration Authorization Act of 1977 (EES); National Energy Conservation Policy Act of 1978 (schools, hospitals, public-care institution programs, and residential conservation services). In addition, there are three other programs: urban waste program, community systems program, and appropriate technology program. Based on a survey of DOE and other Federal agencies, fifty additional programs which have as a primary goal the provision of a service related to reducing energy demand have been identified throughout the Federal government and are included in this report. The main body of the report describes in detail coordination efforts related to all major Conservation and Solar Applications Office energy-conservation programs involving state and local governments. Following one-page summaries of Federal activities contained in Appendix A, Appendix B provides a matrix of the services provided.

50172 (DOE/TIC—10174) **Implementation plan for the Texas Energy Extension Service.** (Texas Energy Extension Service, College Station (USA)). Dec 1977. Contract EC-77-G-01-5096. 102p. P 06/MF A01.

This publication presents compiled data concerning the Energy Extension Service of Texas. Exhibit 1 presents information on program services and technical support for various areas in Texas. Exhibit 2 presents projected rate of service activity (speakers, on-site visits, workshops on energy management and energy conservation). Exhibit 3 summarizes market factors feedback plan for various buildings. Exhibit 4 is to be issued later, and Exhibit 5 tabulates the budget data. Exhibit 6 is the milestone schedules while Exhibit 7 is the quarterly target reports. The schedule for publication/materials is given for Exhibit 8. (MCW)

50173 (DOE/TIC—10175) **C.E.S. implementation plan.** (Michigan Energy Administration, Lansing (USA)). 16 Dec 1977. Contract EC-77-G-01-5092. 208p. P 10/MF A01.

The publication summarizes intensive communication and cooperative planning between the Michigan Energy Extension Service office and the offices of the prime contracting units (C.E.S./M.S.U.—E.R.I.M.). Information is outlined on deviations made from the original proposals. Data on the Cooperative Extension Service Implementation Plan are tabulated and cover the following: C.E.S. Implementation Plan; ERIM/SEMTAP Implementation Plan for Small Businesses and Implementors; Clearinghouse Implementation Plan. Tables on program services and technical support, projected rates of service activity, milestone schedule, and publications and materials are given for each. Additional data and facts on market factors feedback, State's Independent Evaluation Plan, Budget, and quarterly targets are given. (MCW)

50174 (DOE/TIC—10176) **Pennsylvania energy extension service.** (Pennsylvania Governor's Energy Council, Harrisburg (USA)). 31 Oct 1977. Contract EC-77-G-01-5094. 102p. P 06/MF A01.

Since the budget table (Exhibit 5) is central to the entire program rather than the individual modules, it is presented in only this section. Similarly, Sections A, C, and D of the milestone schedule (Exhibit 6) are central to the entire program and are included only in this section. Part I of this document is entitled: Implementation Plan: General Documents. Part II, Statewide Program Implementation Plan, contains the following: Pennsylvania Technical Assistance Program; Department of Community Affairs; and University of Pittsburgh/Hospital Council of Western Pennsylvania. The Geographic Intensive Program Implementation Plan contains data and facts on Core Group; Management Group; Berks County; McKeesport Housing Authority--Governoring Board and Staff; McKeesport Housing Authority--Tenants; Centre Region Council of Governments; Carlisle Borough and School District; Lehigh/Northhampton Counties; and Southern Alleghenies Planning and Development Commission. (MCW)

50175 (DOE/TIC—10183) **Issues and lessons learned in planning and implementing energy extension service local government programs: some case examples.** (Orkand Corp., Silver Spring, MD (USA)). May 1979. 38p. P 03/MF A01.

At the present time, EES programs specifically directed at local government are operating in 6 of the 10 pilot states. These programs in Connecticut, New Mexico, Pennsylvania, Tennessee, Texas, and Wisconsin are described. In two other states, Alabama and Washington, EES and local governments cooperate to enhance their outreach efforts to residential, commercial, and industrial audiences. In Michigan and Wyoming, the remaining EES pilot states, local government activity by EES is minimal or non-existent. In Michigan, EES resources are committed to reaching other target groups since there is a state program for local governments that was already in operation before EES was established. Similarly, in Wyoming, EES focuses on target groups other than local governments. This case study provides information on the activities of each of the pilot states with respect to establishing local government programs. (MCW)

50176 (NP—23875) **Wyoming energy conservation plan.** (Wyoming Energy Conservation Coordinator, Cheyenne (USA)). 28 Mar 1977. 167p. TIC.

This plan is part of an application for a grant under the Energy Policy and Conservation Act (EPCA) to fund a comprehensive energy-conservation effort in the State of Wyoming. The Act offers funding to states (approximately $700,000 for Wyoming through 1979), contingent upon FEA acceptance. All plans must include mandatory lighting and thermal standards, promotion of carpools, conservation in government procurement practices, and a traffic law permitting right turn on red. The plan also must demonstrate a 5% savings in projected 1980 energy consumption. The Wyoming plan meets and exceeds the minimum Federal requirements with twelve primary programs that achieve a 7.5% reduction in projected 1980 consumption. Included are program details related to buildings, transportation, industry, government, education, and agriculture.

50177 (DOE/TIC—10681) **Environmental impact determination: submitted to FEA by The State of North Carolina for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA). Office of Energy Conservation and Environment). [nd]. 18p. P 02/MF A01.

A review of North Carolina's proposed conservation plan was completed. The target of the North Carolina plan, as a whole, is to reduce the State's 1980 energy consumption by 98.87 trillion Btu. This, measured against the 1980 baseline projection for North Carolina of 1736.08 trillion Btu equals a 5.69% savings. Approximately 20.503 trillion Btu (20.7%) of North Carolina's savings come from the five required program measures, which involve state building codes and thermal-efficiency standards, lighting standards for public buildings, life-cycle-cost analysis, increase in transit level of transportation systems, right turn on red. The savings, measured across end-use sectors, resulted in an absolute decrease in every environmental residual measured from each fuel consumed within each sector. (MCW)

50178 (DOE/TIC—10682) **Environmental impact determination: submitted to FEA by The State of New Jersey for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA). Office of Energy Conservation and Environment). [nd]. 19p. P 02/MF A01.

A review of New Jersey's proposed conservation plan was completed, and it was concluded that no significant adverse environmental impacts are expected to result from plan implementation and that beneficial environmental impacts outweigh adverse impacts. The target of the New Jersey plan is to reduce the state's 1980 energy consumption by 139.25 trillion Btu. This, measured against the 1980 baseline projection for New Jersey of 1946.44 trillion equals a 7.15% savings. Savings from the five required program measures will amount to 5.135 trillion Btu. It is seen that the residential and commercial sectors account for 47.3% of New Jersey's total energy consumption and about 62.3% of the projected savings will come from this area. The industrial sector is responsible for 22.1% and about 23.1% of projected savings will amount to about 23.1% while transportation uses about 30.6% of total consumption and savings in this area will amount to 10.2%. About 29% of fuels consumed are for the purpose of generating electricity purchased by the residential, commercial, and industrial sectors. (MCW)

50179 (DOE/TIC—10683) **Environmental impact determination: submitted to FEA by the State of New Mexico for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 22p. P 02/MF A01.

A review of New Mexico's proposed conservation plan was completed. The target of the New Mexico plan, as a whole, is to reduce the State's 1980 energy consumption by 42.266 trillion Btu. This, measured against the 1980 baseline projection for New Mexico of 605.79 trillion Btu equals a 6.97% savings. Approximately 4.752 trillion Btu (11.2%) of savings come from the five required program measures, which involve state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis (procurement), increase in transit level of transportation systems, and right turn on red. No significant environmental impacts were expected from implementation of the plan. (MCW)

50180 (DOE/TIC—10684) **Environmental impact determination: submitted to FEA by the State of Montana for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 15p. (Dep. NTIS, PC 02/MF A01). 02.

A review of Montana's proposed conservation plan was completed. The impact of the Montana plan, as a whole, will be - if successful - to reduce the state's 1980 energy consumption by 19.502 trillion Btu; of this 12.512 trillion Btu will be non-electrical and 6.99 trillion Btu will come from fuels used to generate electricity. This, measured against the FEA 1980 baseline projection for Montana of 370.54 trillion Btu, equals savings of about 5.3%. Montana's projected 1980 consumption and SECP savings represent about 0.5% of the national total. The required program measures account for 15.33 trillion Btu or 64% of total savings. The required measures deal with state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis (procurement), increase in transit level of transportation, and right turn on red. Evidence was provided that potential environmental impacts were carefully considered throughout development of the plan; no significant adverse impacts were identified. (MCW)

50181 (DOE/TIC—10685) **Environmental impact determination: submitted to the FEA by the State of Minnesota for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 23p. P 02/MF A01.

Energy savings to result from implementation of the Minnesota plan are estimated at 122.3 trillion Btu or 8.9% of the FEA baseline forecast for Minnesota, for 1980, of 1361.1 trillion Btu. However, not all of these savings are to result from program measures for which Minnesota is requesting approval or funding (total or partial) under provisions of the SECP. Table IV-B (appended) of the plan submission lists the SECP program measures and their related savings. These savings amount to 71.2 trillion Btu or 5.2% of the 1980 projection. Of this total, 17.4 trillion Btu (or 24.4% of savings) are attributed to the five required program measures (state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis, increase in transit level of transportation systems, right turn on left). The remaining 53.8 trillion Btu are realized from some 14 additional measures. Of the 71.2 trillion Btu, 9.9 trillion Btu are electrical generation fuels saved (6.2 of coal and 3.7 oil); this is about 14% of primary fuel savings. No significant adverse environmental impacts were expected from implementation of the plan. (MCW)

50182 (DOE/TIC—10694) **Environmental impact determination: submitted to the FEA by the State of Massachusetts for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 18p. P 02/ MF A01.

A review of Massachusetts' proposed conservation plan was completed. The impact of the Massachusetts plan, as a whole, will be - if successful - to reduce the State's 1980 energy consumption by 121.31 trillion (10^{12}) Btu; of this 70.45 x 10^{12} Btu will be non-electrical and 50.86 x 10^{12} Btu will come from fuels used to generate electricity. This, measured against the FEA 1980 Baseline projection for Massachusetts of 1,683 trillion Btu, equals a 7.2% savings. No significant adverse environmental impacts were expected from implementation of the plan. (MCW)

50183 (DOE/TIC—10695) **Environmental impact determination: submitted to the FEA by the State of Colorado for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 22p. P 02/ MF A01.

A review of Colorado's proposed conservation plan was completed. The target of the Colorado plan, as a whole, is to reduce the State's 1980 energy consumption by 64.43 trillion Btu. This, measured against the 1980 baseline projection for Colorado of 934.04 trillion Btu equals a 6.9% savings. Approximately 13.50 trillion Btu (21.0%) of Colorado's savings come from the five required program measures, which involve state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis (procurement), increase in transit level of transportation systems, right turn on red. These savings, measured across end use sectors, result in an absolute decrease in every environmental residual measured from each fuel consumed within each sector. (MCW)

50184 (DOE/TIC—10696) **Environmental impact determination: submitted to FEA by the State of California for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 45p. P 03/ MF A01.

A review of California's proposed conservation plan was completed. The impact of the California plan, as a whole, will be - if successful - to reduce the State's 1980 energy end use consumption by 386.71 trillion (10^{12}) Btu; of this, 313.2 x 10^{12} Btu will be non-electrical and 73.51 x 10^{12} Btu will come from the electrical sector. Total savings will amount to 542.71 trillion Btu (313.2 non-electrical and 229.51 in fuels used to generate electricity). This, measured against the FEA 1980 baseline projection for California of 6896.58 trillion Btu, equals a 7.7% savings. An additional benefit of implementing the plan is the reduction of environmental degradation that results from the conversion, distribution, and use of energy; a quantified estimate of these benefits is presented. (MCW)

50185 (DOE/TIC—10697) **Environmental impact determination: submitted to FEA by the State of Arizona for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 19p. P 02/ MF A01.

A review of Arizona's proposed conservation plan was completed. The target of the Arizona plan, as a whole, is to reduce the state's 1980 energy consumption by 38.4599 trillion Btu. This, measured as against the 1980 baseline projection for Arizona of 793.94 trillion Btu equals a 4.8% savings. A savings of 29.4% came from the five required program measures. No significant adverse environmental impacts were expected from implementation of the plan. In Arizona, it is seen that the residential and commercial sectors account for about 32.4% of total energy consumption and (through lighting and thermal efficiency programs) about 76.1% of projected savings; the industrial sector is responsible for 30.1% of total consumption and about 15.5% of savings; while transportation uses about 37.5% of the total consumption and accounts for about 8.4% of total savings; and about 35.7% of all fuels consumed are for the purpose of generating electricity purchased by the residential, commercial, and industrial sectors.

50186 (DOE/TIC—10698) **Environmental impact determination: submitted to FEA by the State of Arkansas for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 20p. P 02/ MF A01.

A review of the Arkansas proposed conservation plan was completed. The target of the Arkansas plan, as a whole, is to reduce the State's 1980 energy consumption by 86.411 trillion Btu. This, measured against the 1980 baseline projection for Arkansas of 917.10 trillion Btu equals a 9.42% savings. 10.081 trillion Btu (11.9%) of Arkansas' savings come from the five required program measures, which involve state building codes and thermal efficiency standards, lighting standards for public buildings, life-cycle-cost analysis, increase in transit level of transportation systems, right turn on red. These savings, measured across end-use sectors resulted in an absolute decrease in every environmental residual measured from each fuel consumed within each sector. (MCW)

50187 (DOE/TIC—10699) **Environmental impact determination: submitted to the FEA by the State of Michigan for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 39p. P 03/ MF A01.

Portions of document are illegible.

A review of Michigan's proposed conservation plan has been completed. The target of the Michigan plan, as a whole, is to reduce the state's 1980 energy consumption by 258.9 trillion Btus. This, measured against the 1980 baseline projection for Michigan of 3,299.78 trillion Btu equals a 7.8% savings. Approximately 53 trillion Btu (20.5%) of savings will come from the five required program measures. It is seen that the residential and commercial sectors account for about 41% of total energy consumption and (through lighting and thermal efficiency programs) about 35% of projected savings; the government sector (where savings come predominantly from improved building efficiency) accounts for another 7%. The industrial sector is responsible for 34.5% of total consumption and about 32% of savings; while transportation uses about 24% of the total consumption and accounts for about 13% of total savings. About 26% of all fuels consumed are for the purpose of generating electricity purchased by the residential, commercial, and industrial sectors. No significant adverse environmental impacts were expected from implementation of the plan.

50188 (DOE/TIC—10700) **Environmental impact determination: submitted to the FEA by the District of Columbia for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 21p. P 02/ MF A01.

A review of the District of Columbia's proposed conservation plan has been completed. The target of the District of Columbia plan, as a whole, is to reduce the District's 1980 energy consumption by 21.751 trillion Btu. This, measured against the 1980 baseline projection for the District of 239.64 trillion Btu equals a 9.07% savings. Approximately 8.539 trillion Btu (39.2%) of D.C.'s savings come from the five required program measures, which involve state building codes and thermal-efficiency standards, lighting standards for public buildings, life-cycle-cost analysis (procurement), increase in transit level of transportation systems, and right turn on red. No significant adverse environmental impacts were expected from implementation of the plan. (MCW)

50189 (DOE/TIC—10701) **Environmental impact determination: submitted to the FEA by the the State of Utah for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 18p. P 02/ MF A01.

The Energy Policy and Conservation Act establishes the State Energy Conservation Program. An Environmental Assessment of the probable nationwide impacts of the FEA. A review of Utah's proposed conservation plan was completed. The target of the Utah plan, as a whole, is to reduce the State's 1980 energy consumption by 33.9 trillion Btu. This, measured against the 1980 baseline projection for Utah of 554.07 trillion Btu equals a 6.11 percent savings. Approximately 6.8 trillion Btu (20.1%) of Utah's savings come from the five required program measures, which involve state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis (procurement), increase in transit level of transportation, and right to turn on red. No significant environ-

mental impacts were expected from implementation of the plan. (MCW)

50190 (DOE/TIC—10702) **Environmental impact determination: submitted to the FEA by the the State of Pennsylvania for approval and funding under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 20p. P 02/MF A01.

A review of Pennsylvania's proposed conservation plan was completed. If the Pennsylvania goal is achieved, the impact of the plan, as a whole, will be to reduce the State's 1980 energy consumption by 301.61 trillion (10^{12}) Btu; of this, 239.50 x 10^{12} Btu will be non-electrical and 62.11 x 10^{12} Btu will come from fuels used to generate electricity. This, measured against the FEA 1980 baseline projection for Pennsylvania of 4,360.96 trillion Btu, equals a 6.9% savings. These savings, measured across end-use sectors, result in an absolute decrease in every environmental residual measured from each fuel consumed within each sector. This should indicate that conservation opportunities are also fairly evenly distributed. Judging from the Commonwealth's plan, this is, indeed the case. The residential and commercial sectors combined (where building heating, lighting, and cooling are the largest energy users) account for about 31% of end use consumption; 34.6% of targeted savings are from this area. The transportation ratio is 20.2% to 13.4% and for industry it is 48.8 to 52. (MCW)

50191 (DOE/TIC—10703) **Environmental impact determination: submitted to FEA by the State of North Dakota for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 16p. P 02/MF A01.

A review of North Dakota's proposed conservation plan was completed. The target of the North Dakota plan, as a whole, is to reduce the State's 1980 energy consumption by 12.31 trillion Btu. This, measured against the 1980 baseline projection for North Dakota of 164.55 trillion Btu equals a 7.48% savings. Approximately 2.37 trillion Btu (19.26%) of North Dakota's savings will come from the five required program measures, which involve state building codes and thermal efficiency standards, lighting standards for public buildings, life cycle cost analysis (procurement), increase in transit level of transportation, and right turn on red. No significant adverse environmental impacts were expected from implementation of the plan. (MCW)

50192 (DOE/TIC—10704) **Environmental impact determination: submitted to FEA by the State of Oklahoma for approval and fundng under the provisions of Title III, Part C of the Energy Policy and Conservation Act; State Energy Conservation Program.** (Federal Energy Administration, Washington, DC (USA)). [nd]. 71p. P 04/MF A01.

Oklahoma has prepared a detailed and comprehensive Environmental Assessment (EA) of its proposed State Energy Conservation Plan. A review of the plan and the EA was completed by FEA. It is concluded that energy savings to result from implementation of the Oklahoma plan are estimated at 97.25 trillion Btu. Of this total 41.58 trillion Btu will be non-electrical, 16.72 trillion will be net electrical end use consumption and 38.95 trillion will constitute energy lost in electrical generation. Put another way, 55.67 trillion Btu will be saved from fuels used to generate electricity; net (end use) savings will amount to 58.30 trillion Btu. Of the latter, 16.60 will come from the five required program measures and 41.70 from others. No significant adverse environmental impacts were identified from implementation of the plan.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 49481, 50161, 50164, 50220, 50221, 50223, 50224, 50225, 50226, 50227, 50228, 50229, 50231, 50232, 50600

50193 (DOE/IA—0002/01) **Joint Egypt/United States report on Egypt/United States cooperative energy assessment. Volume 1 of 5 Vols. Executive summary, main report and appendices.** (Department of Energy, Washington, DC (USA)). Apr 1979. 408p. P 18/MF A01.

The International Energy Assessment Program between Egypt and the U.S. was formulated from mid-March to mid-July, 1978. The assessment identified energy demand and supply options for Egypt that are consistent with its indigenous energy resources; assessed Egypt's ability to effectively use those options; and identified measures by which Egypt's energy-planning activities could be improved. The assessment addressed all known and potential energy supply options (oil, gas, coal, oil shale, hydroelectric, nuclear power, geothermal, solar, wind, and biomass). Using the Reference Energy System, two future energy supply/demand balances are constructed (for 1985 and the year 2000) and these are compared with a historical (1975) supply/demand balance. The feasibility of each of the options is established in terms of the availability of the required resources and of the processing, conversion, transport, and utilization technology.

50194 (DOE/IA—0002/02) **Joint Egypt/United States report on Egypt/United States cooperative energy assessment. Volume 2 of 5 Vols. Annex 1.** (Department of Energy, Washington, DC (USA)). Apr 1979. 215p. P 10/MF A01.

Detailed summaries are presented of Egypt's indigenous energy resources from the U.S. Geological Survey assessments; preliminary information collected early in 1977 from files, reports, and publications existing in the U.S.; and data gathered during one-month assessment program in March—April 1978. Detailed reports are given on oil and gas, coal and oil shale, uranium and thorium, geothermal energy, water resources, and energy-related minerals/commodities. An assessment of cement-making materials, iron ore, manganese, aluminium, barite, bentonite, copper, chromium, nickel, titanium, and miscellaneous metals used in steel making is presented.

50195 (DOE/TIC—10483) **Proposed gasoline and diesel fuel rationing contingency plan. Management summary.** (Federal Energy Administration, Washington, DC (USA)). Apr 1977. 84p. P 05/MF A01.

The objectives of the rationing plan are described in Section A. Other areas discussed are: conditions leading to rationing; gasoline rationing plan operations; diesel fuel rationing plan operations; program administration and resources; rationing implementation plan.

50196 (DOE/TIC—10775) **Proposed Gasoline and Diesel Fuel Rationing Contingency Plan. Economic impact analysis.** (Federal Energy Administration, Washington, DC (USA)). Apr 1977. 308p. P 14/MF A01.

An analysis of the economic impacts of FEA's proposed Gasoline and Diesel Fuel Rationing Plan is presented. The various components of the proposed plan is evaluated in terms of the effect on the economic factors identified in the 1975 Energy Policy and Conservation Act. The scope of the study was confined to the economic impacts of the rationing plan relative to an economy already impacted by the embargo and the mandatory allocation program. Time constraints imposed on the analysis required reliance on secondary data and a qualitative approach in some areas.

50197 (MASEC/TR—1) **North Central Region energy situation.** Scott, M.G. (MASEC Corp., Eagan, MN (USA)). 1 May 1979. Contract EM-78-C-01-5137. 52p. P 04/MF A01.

The Mid-American Solar Energy Complex (MASEC) issues numerous topical reports covering energy topics of interest to the 12 North Central States. This report provides an overview of the relative status of national and regional energy situations. The influence of various governmental policies on availability and distribution channels for conventional energy sources (e.g., oil, natural gas, electricity, and coal) is traced. Numerous figures and tables outline existing and forecasted amounts of regional energy demands and supplies. Areas where energy shortages are likely to occur are also identified. The report is narrowed to a manageable length by focusing on major energy supplies and their availability for the various geographical areas of the region. Little mention is made of future energy prices or solutions. Rather, the goal is to help those in the region to better understand the present and future energy picture. If successful, the report will show where energy shortages could occur and how to plan for these future energy related problems.

50198 (NP—23851) **New York State energy consumption and supply statistics, 1960—1976.** Tarantino, J.; Schultz, M.; Searle, C. (New York State Energy Research and Development Authority, New York (USA)). 1978. 90p. NTIS, PC A05/MF A01.

Data are presented on New York energy consumption and supply necessary to analyze present and future resource use and supply within the state. The report presents a summary of total consumption of primary resources in New York by fuel type for the period 1960 through 1976; the total direct consumption of each fuel by sector and final end use for 1975 and 1976; the sources of energy consumed in New York including production of primary resources within the state and the origin of petroleum and natural gas delivered into the state; and a preliminary estimate of 1977 primary energy consumption by fuel type and corresponding 1975 and 1976 data. Additional information and data are presented in 8 appendices. Extensive tables and graphs on petroleum, natural gas, coal, hydro, and nuclear power required for producing heat and power are included.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 49472, 49473, 49632, 50154, 50155, 50156, 50171, 50213, 50216, 50242, 50243, 50244, 50245, 50246, 50247, 50248, 50272

50199 (CONF-7805161—) **Proceedings of the first Seattle workshop on incentives used to stimulate energy production.** Cone, B.W. (ed.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1979. Contract EY-76-C-06-1830. 248p. P 11/MF A01.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The introductory paper of this workshop was an overview of report PNL-2410, an Analysis of Federal Incentives Used to Stimulate Energy Production; the next four papers critiqued the report. The next 28 presentations were from individuals or various workshop discussion groups on either incentives for solar energy development or for energy source development in general. A separate abstract was prepared for each.

50200 (CONF-7805161—, pp 1.1-1.7) **Introduction: incentives report overview.** Cone, B.W. (Pacific Northwest Lab., Richland, WA); Bezdek, R.H. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

This is the introductory paper to the workshop on incentives. The workshop was based on the research report entitled An Analysis of Federal Incentives Used to Stimulate Energy Production, PNL-2410. The purpose of the research presented in that report was to analyze past and present Federal incentives to production of various energy sources and thereby assist the Division of Conservation and Solar Application, Department of Energy, in the study and recommendation of Federal incentives for the development of solar energy. The conclusions of this research were that the Federal Government has provided billions of dollars for incentives to stimulate energy production and therefore a precedent exists to spend large sums of money to promote solar energy production. The workshop proposed to create and record interaction among a heterogeneous group of identified contributors to energy policy. Potential contributors were asked to write short papers in direct response to specific parts of the research report or to supplement information presented in a section in the final chapter of the report entitled "Possible Solar Incentives."

50201 (CONF-7805161—, pp 2.1-2.6) **Critique of the incentives report: the policy issues of equity and efficiency.** Sparrow, T. (Purdue Univ., West Lafayette, IN). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The author's critique of the research in PNL-2410, An Analysis of Federal Incentives Used to Stimulate Energy Production, focuses on the conversion of generated data into a form useful for solar-incentive policy by presenting the equity and efficiency issues. From a compilation of energy-related government organization outlays for 1976 the author determines the government spent 36 cents/10^6 Btu. The problem of an equitable solar subsidy to put solar on an equal footing with other subsidized energy sources is not as simple as a 36 cents subsidy. The author outlines some other social costs and social benefits that should be considered.

50202 (CONF-7805161—, pp 2.7-2.13) **Critique of the incentives report: the sources of Federal energy incentives - a policy assessment.** Hammarlund, J. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The author's critique of the research in PNL-2410, An Analysis of Federal Incentives Used to Stimulate Energy Production focuses on the analytical framework of the report and determines that the choice of policy definitions guides the subsequent analysis in certain directions. In attempting to draw boundaries around the notion of "public policy", the report focuses on concrete governmental actions at the Federal level in which energy related issues have been either an important cause or an important effect. While this approach is not unreasonable, the author contends that the definition also contains some ambiguities and substantially restricts the policy analysts's search for reason behind the artificial secular supply curve.

50203 (CONF-7805161—, pp 2.15-2.24) **Critique of the incentives report: political economy and solar market penetration.** Lindberg, L.N. (Univ. of Wisconsin, Madison). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The author's critique of the reseach report PNL-2410, An Analysis of Federal Incentives Used to Stimulate Energy Production, centers on the four viewpoints of the research report used to identify energy policy actions in terms of causes and effects - economic, political, organizational, and legal. The author suggests that the way in which the four viewpoints are developed and juxtaposed leaves unexplored a number of important policy issues relative to the rapid deployment of solar energy in the United States. Basic social questions are analyzed from three viewpoints - pluralist, elitist, and class. Market penetration on the production side and the dynamics of industrial adaptation are discussed. An expanding state role in energy production is analyzed. The author suggests that a close examination of the government's nuclear energy policies would be very instructive before rapid deployment of solar energy. 5 references.

50204 (CONF-7805161—, pp 2.25-2.28) **Critique of the incentives report: some other non-quantifiable incentives for nuclear energy.** Hauer, C.R. (Planning Research Corp., McLean, VA). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The author's critique of the research report PNL-2410, An Analysis of Federal Incentives Used to Stimulate Energy Production, addresses several nonquantifiable incentives to nuclear energy development. Assumptions made in that report concerning the contribution of the military nuclear technology tend to undervalue the subsidies for the utilization of nuclear energy. The military's nuclear technology research accelerated the development not only of nuclear energy in general, but of the light water reactor in particular. The public relations program waged by the Atomic Energy Commission and the Joint Committee on Atomic Energy promising almost free electricity from the atom was a hidden but powerful incentive. The creation of a nuclear infrastructure of national laboratories and mixed civilian/military educational program also greatly benefited the nuclear industry.

50205 (CONF-7805161—, pp 3.31-3.35) **Federal energy taxes and subsidies.** Flaim, S.J. (Solar Energy Research Inst., Golden, CO). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

In the United States, energy taxes are imposed on production, property, sales, and income. The Federal government collects income taxes, royalties from production on Federal lands, and sales taxes on energy products. Practically from the inception of income taxes, the tax burden on energy industries has been reduced - presumably to stimulate energy production. These incentives or excessive tax deductions and credits are generally regarded as subsidies. Their nature and extent, particularly as they apply to the energy industries, are not fully known; and the rationale underlying these provisions has been tested only superficially. This paper identifies the major subsidy provisions affecting energy production but does not attempt to quantify their magnitude or impact and does not note changes in these provisions since their enactment. It was concluded that a preferred means of achieving a fair tax treatment for solar would be by eliminating all the subsidies for conventional fuels. Elimination of these subsidies would increase the costs of conventional fuels and make solar cost competitive in its own right.

50206 (CONF-7805161—, pp 3.37-3.41) **Shifting and incidence of taxes and subsidies.** Babcock, W. (Booz, Allen, and Hamilton, Bethesda, MD). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Of importance in analyzing Federal incentives used to stimulate energy production is the distinction between the initial impact of the subsidy and the final incidence of the subsidy. While the initial impact of the subsidy could be on an energy producing firm it is not at all clear that the subsidy will be passed on to the consumer in the form of increased output or decreased price. Therefore, the final incidence, and the potential effects of a subsidy, must be analyzed before a statement can be made regarding its influence on energy activities. As a first step in analyzing the effects of alternative subsides on the corporate sector it is beneficial to analyze the effects of the existence of the corporate income tax on a firm's solar investment decision. A detailed analysis of the effect of the existing corporate income tax code on a corporation's solar investment decision has been conducted in this report. Investment decisions made on the basis of both life-cycle cost comparisons and expected payback periods are analyzed. It is shown that the existing corporate income tax code does not distort a corporation's solar investment decision if the present value (PV) of allowable capital-expense tax deductions (interest payments and depreciation deductions) over the relevant decision period are equal to the PV of actual capital expenses.

50207 (CONF-7805161—, pp 3.47-3.49) **Incentives: a capital idea.** Anderson, R. (Office of Energy Management and Conservation, Olympia, WA). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The Washington State Legislature enacted a Life-Cycle Cost Analysis Act that applies to all publicly-owned and leased facilities

of 25,000 square feet or more. This act constituted a major change in philosophy for "first cost is the only consideration" to "first cost, operational costs, and maintenance costs need consideration." Unfortunately, just because an analysis shows which system is the most efficient it does not mean the most-efficient system is constructed. The author makes the point that conservation and solar efforts diminish the requirement for new facilities for power generation and the capital dollars spent on conservation and solar provide a much greater return on the investment. The author suggests that since new thermal generation facilities are being financed by a legislatively created organization a similar organization could be created to provide financing for conservation and solar efforts. Funding would be provided by a surcharge on electricity, natural gas, and oil. The consumer would apply to this organization for the funds to offset his capital costs up to the equivalent amount of new plant that is being offset.

50208 (CONF-7805161—, pp 4.30-4.32) **Types of incentives: nontraditional government services.** Williams, A. (State Senate, Seattle, WA); Harty, H.; Thompson, C.; Veigel, J.; Wilson, R.; Yokelly, M. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Nontraditional government services such as knowledge acquisition, dissemination, and professional services were examined. A major concern to this discussion group was that expectations about the results of research and development could surpass results and thereby have a counterproductive effect. Members felt that there is a great deal of awareness in government of the need to avoid institutionalizing specific incentives. The consensus was that it is not so much the incentives that become institutionalized as it is the self-perpetuation of institutions by those with vested interests.

50209 (CONF-7805161—, pp 4.38-4.43) **Types of incentives: reorganization and requirements.** Lindberg, L. (Univ. of Wisconsin, Madison); Cole, R.; Nassikas, J.; Hammerlund, J.; Watson, R. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

It was felt that the administration of environmental laws has had probably the single most important influence on current energy production. This discussion group was very sensitive to the problem of placing more requirements on an increasingly protesting public. They felt that there is a possible problem of resistance, for requirements placed on individuals may reinforce the behavior being prohibited, rather than abolishing it. The judicial process seemed to be the most important element in the requirements incentive.

50210 (LA—7909-MS) **Energy policy and decision analysis: new concepts and mechanisms.** Kaufman, E.L.; Vogel, R.W. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 52p. P 04/MF A01.

The US has entered an administrative era much more complex than that which existed earlier. The present technique used for policymaking and public problem solving was developed decades ago and is no longer appropriate. Today's energy dilemmas are symptomatic of an administrative management system that cannot function within the necessary time frames. Similar dilemmas can be expected in other categories that cut across government organizational structure. If questions of energy independence, or at what rate can imports be reduced, while maintaining a reasonable rate of growth, are important, the technique presented offers a means for answer. However, commitment to change is required. The change is not merely the exchange of bureaucracies for the sake of change, but a switch in the manner in which dependable decisions are made. This paper describes relevant portions of the energy-management problem and a technique wherein objective energy policy analysis can be performed in a short time frame. A precept for decision criteria is proposed and a set of fundamental concepts are described that allow quantitative assessment of policy and decision consequences for the total energy system. A decision conferencing is described wherein the technical assessment is combined with the political acumen of experienced decision makers to allow the best public-interest choice to be made. A rationale is also presented for the organizational placement of the analysis function, outside of government or industry. This placement will provide a much needed level of credibility, higher than that which presently exists, and will reduce bias and equitably balance the needs of the public, government, and industry.

50211 (NP—23896) **Legislating for energy independence: the Legislative Commission on Energy Systems. Report to the Governor and the Legislature on its studies.** (New York State Legislative Commission on Energy Systems, Albany (USA)). Sep 1978. 141p. Q 07/MF A01.

The goals of the Legislative Commission on Energy Systems, established in 1975, are to foster legislation which will minimize the impact of the energy crisis upon the citizens of New York State, while maintaining economic growth and a healthy environment. The Commission has in the past initiated major energy legislation such as that establishing the State Energy Office and several acts involving financing, standards, and tax-abatement for energy-saving systems. The Commission's role in the Legislature is to gather and provide information in the field of energy by means of hearings, conferences, and research; to prepare legislation dealing with energy; and to coordinate the many facets of the energy problem which are handled separately by several standing committees. The Commission has presented nine bills as priority legislation for the 1978 Session, and has cooperated in the preparation and passage of legislation for the State Energy Plan.

50212 **14 thesis to the world energy problem.** Basov, N.G. (AN SSSR, Moscow. Inst. Fiziki); Bethe, H.A. (Cornell Univ., Ithaca, N.Y. (USA)); Cohen, K. (Cornell Univ., Ithaca, N.Y. (USA)); Culler, F. (Oak Ridge National Lab., Tenn. (USA)); Hofstadter, R. (Stanford Univ., Calif. (USA)); Kursunoglu, B. (Miami Univ., Coral Gables, Fla. (USA). Center for Theoretical Studies); Lewis, W.B. (Queen's Univ., Kingston, Ontario (Canada)); Meinel, M.P. (Arizona Univ., Tucson (USA)); Oshima, K. (Tokyo Univ. (Japan)); Teller, E. (Stanford Univ., Calif. (USA)). *Chem. Ztg.;* **102**: No. 7, 255(Jul-Aug 1978). (In German).

From International scientific forum on an acceptable nuclear future for the world; Fort Lauderdale, Fla. (7 - 11 Nov 1977).

FOSSIL FUELS

REFER ALSO TO CITATION(S) 50266

COAL

REFER ALSO TO CITATION(S) 49430, 49433, 49442, 49464, 49469, 49472, 49473, 49853, 49856

50213 (CONF-7805161—, pp 3.21-3.24) **TVA incentives to stimulate the availability and utilization of coal.** Macphee, B. (Tennessee Valley Authority, Chattanooga). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

A major obstacle to the increased use of coal by electric utilities and other industries is the environmental damage caused by its production and use. TVA has initiated several programs to alleviate the environmental damage associated with the use of coal. Since 1965 TVA has included provisions in its long- and short-term contracts requiring coal producers to reclaim strip-mined lands. At that time, no Federal reclamation requirements were in effect, few states had enacted such requirements, and no existing state reclamation requirements were as rigorous as those imposed by TVA. The standards set by TVA placed all coal producers on an equal footing and eliminated cost advantages of coal producers in states with no reclamation requirements. From 1972 to 1976 TVA conducted an experimental strip-mining operation on TVA-owned reserves. Cost and productivity information collected during the four-year program provided actual mining experience in advanced underground mining techniques such as longwall, shortwall, and hydraulic mining methods. In 1976 appropriated funds were approved to reclaim orphan strip-mine lands with TVA administering the program. The program is providing minimum reclamation needed to prevent continued offsite damage and to return the orphaned lands to productive use. TVA also has demonstration and research programs underway involving limestone scrubbers, coal washing facilities (to utilize high-sulphur eastern coal), waste byproduct utilization, fluidized bed furnaces, and magnetohydrodynamics.

50214 (CONF-7805161—, pp 4.13-4.14) **Energy sources: coal incentives.** McPhee, B. (Tennessee Valley Authority, Chattanooga); Sheppard, B.; Boleyn, D.; Esterling, J.; Babcock, W. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

In discussing incentives for coal production, it was determined that taxation in the form of the percent depletion allowance acted as the greatest incentive for coal producers. The impetus for the depletion allowance came from a drive by non-petroleum extractive industries to secure the same benefits as oil and gas producers. Group members concurred with those in the oil group, concluding that the Mine, Health, and Safety Act has had an inhibiting effect on the production of coal and was therefore a negative incentive.

PETROLEUM

REFER ALSO TO CITATION(S) 49481

50215 (CONF-7805161—, pp 4.10-4.12) **Energy sources: oil incentives.** Sparrow, T. (Purdue Univ., West Lafayette, IN); Brenchley, D.; Bezdek, R.; Koomanoff, F.; Benveniste, J. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

This discussion group felt that foreign tax credits were disincentives to domestic production while oil-import quotas were incentives. When the Federal government ignores safety, environmental and health costs, it creates a tacit incentive to production within the industry; therefore lack of strict regulations have aided the oil producers. Multiple-tiered pricing of oil was viewed as a disincentive.

NATURAL GAS

REFER ALSO TO CITATION(S) 49487, 49493, 49494

50216 (CONF-7805161—, pp 3.3-3.20) **Role of gas energy.** Nassikas, J.N. (Cox, Langford & Brown, Washington, DC). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Evaluation of the role of gas energy in the energy spectrum offers perspective in formulating the elements of a national solar energy policy. In order to offer viable incentives to develop solar energy, the availability of all energy resources should be recognized. The author gives a history and analysis of federal incentives as well as disincentives in the natural gas industry. According to the author, the allocation of Federal funds to solar should be governed by the pragmatic test of return to the national interest from the investment commitment, which would not be made by private industry without government intervention. The solar commitment must be coordinated with commitments for the development of other energy resources within the time frame to supply energy for an expanding economy at optimum societal cost. 5 tables.

50217 (CONF-7805161—, pp 4.5-4.10) **Natural gas incentives.** Nassikas, J. (Cox, Langford & Brown, Washington, DC); Cole, R.; Cone, B.; Savitsky, G. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

This discussion group felt the depletion allowance was the greatest incentive to natural gas production. Gaps between initial regulatory legislation and final court decisions and the attention of the press were labeled disincentives. Group members agreed that the priority given to residential use of gas did not have a significant effect on the amount of gas produced. The members believed that marginal-cost pricing would have a greater impact on inducing increased gas than average cost pricing. While a plea was made to let the market function where it can, there was a consensus of need for a government mechanism to develop a price floor. Any government involvement in incentives was regarded as dynamic since the group felt that incentives that help an industry develop could hurt that industry's expansion as it matures, for regulation of proven technology is much simpler than regulation of developing technology.

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 49442, 49598

ELECTRIC POWER

REFER ALSO TO CITATION(S) 49599, 50168, 50241

50218 (DOE/ERA—0052/1(Rev.)) **ROSTER: Emergency Electric Power Administration. Appendix 3.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Aug 1979. 76p. P 05/MF A01.

The Emergency Electric Power Administration national headquarters personnel; area map; directors, deputies, and regional power liason representatives; state power liaison representatives; major utility representatives are given. A map of the Federal Emergency Management Administration is given and directors of the regional offices are listed.

50219 (DOE/ET—5109-1) **Development of an electrical load demand and response model based on a rational synthesis from elementary devices.** (Georgia Inst. of Tech., Atlanta (USA)). Jul 1979. Contract EM-77-S-01-5109. 89p. P 05/MF A01.

This project develops and tests a viable methodology which can be used to synthesize models of power-system load to aid in the following major functions: on-line automatic generation control; short-term bus load forecasting; stochastic power-flow analysis; load management; operational planning; security assessment; and power-system stability analysis. The scope of the project is limited to the development of methodology with all associated simulation programs. In order to avoid functioning in a vacuum, a limited amount of information obtainable from utilities and government agencies are utilized in providing a credible data base for the validation methodology and the tuning of model parameters. Although the developed models are primarily useful in the system operation context, the potential planning uses are properly delineated. The methodology develops two types of load models—load demand and load-response.

50220 (DOE/TIC—10168(Vol.1)) **Procedures for independent analyses of electric energy and peak loads by state agencies.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1978. Contract EM-77-C-01-8725. 350p. P 15/MF A01.

This study was commissioned to aid states in developing improved procedures for independently forecasting the demand for electricity and the need for power facilities. It provides guidance to those states that presently have only modest capabilities in the development of tools for load forecasting and in the evaluation of the implications of those forecasts. Arizona, New Jersey, North Carolina, and Wisconsin provided a continuous advisory role. Present procedures development and load-forecasting staffing are characterized by the states. Following discussions with the state officials and a review of their state procedures, Chapters 3 through 6 develop procedures for forecasting the demand for electric energy - residential, commercial, industrial, and other. Chapter 7 discusses peak load forecasting, and Chapter 8 provides illustrative simulations of the model using data pertaining to the 4 states that cooperated in its development.

50221 (DOE/TIC—10168(Vol.2)) **Procedures for independent analyses of electric energy and peak loads by state agencies.** (Charles River Associates, Inc., Boston, MA (USA)). Jul 1978. Contract EM-77-C-01-8725. 252p. P 12/MF A01.

This report reviews existing studies and forecasting models for energy sales and peak demand. The review is focused toward approaches to forecasting that can be implemented by state public utility commissions (PUCs) and other state agencies with interests in forecasting the effects of energy policies on electricity sales and peak demands. As such it points toward model design and development tasks. The selection of studies focuses on those which are leading examples of state-of-the-art approaches of some potential applicability to the modeling problems of state PUCs and energy agencies. A conclusion drawn from this survey is that several important aspects of electricity demand modeling have not yet been treated effectively. Another conclusion is that the state models must be relatively sophisticated in order to be reliable forecasting tools. PUCs with little experience in forecasting and data management will find it necessary to increase their analytical capabilities in order to use the models. Chapters 2 to 4 of this report review electric energy demand models specific to the residential, commercial, and industrial customer loads. Chapter 5 critically surveys methods of constructing peak-load forecasts. The final two chaptrs sample electricty demand forecasting procedures currently used by state agencies and utilities.

50222 (DOE/TIC—10664) **Study of the treatment of construction work in progress and tax-timing differences for rate-making purposes in the electric utility industry.** (Andersen (Arthur) and Co., Washington, DC (USA)). 25 Mar 1977. 360p. P 16/MF A01.

A study was prepared encompassing a background analysis of the effects of the inclusion of Construction Work in Progress in the rate base and normalization of all income tax costs of the electric utility industry. These effects are in relation to consumers of electricity, the investor owned electric utilities, bondholders, stockholders, and the public as a whole. Section I is a review of the construction requirements of the industry during recent years and as projected by the industry for the next 10 years and Section II is an analysis of the problems facing the industry in financing these requirements. An analysis of the rate making concept of including CWIP in the rate is given in Section III while an analysis of the rate making concept of full normalization of income taxes is given in Section IV. Section V presents a bibliography of books, articles, speeches and presentations, regulatory commission orders, public testimony, and other sources of information which were reviewed. The final section contains the report and independent conclusions of Duff and Phelps, Inc., utility financial analysts, who were retained to review these matters from the viewpoint of investors in electric utility securities. They conclude that large construction investments increase the cost of capital but such cost could be avoided to the extend of 30 to 70 basis points if CWIP were included in rate base in constrast to excluding it from the rate base and capitalizing AFUDC. (MCW)

50223 (EPRI-EA—1035-SR) **How electric utilities forecast: EPRI symposium proceedings.** Crow, R.T. (ed.). (Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1979. 364p. (CONF-771276—). P 16/MF A01.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

This symposium was organized to provide electric-utility forecasters an opportunity to learn from colleagues the current state of the forecaster's art. The emphasis of this symposium was on practice and application. Each person invited to give a paper was directly employed by an electric utility or was a consultant designated by a utility to represent that utility's forecasting methodology. Thus, all the papers presented discussed forecasting approaches currently in use by electric utilities. The symposium sought to include a wide range of forecasting philosophies. Of the 20 presentations made in six sessions, 17 papers were submitted for publication in the proceedings. Topics for the six sessions were: Forecasting Residential Kilowatthour Consumption, Forecasting Peak Demand and Load Shape, Forecasting Commercial Kilowatthour Consumption, Forecasting Problems of Small Utilities, Forecasting Industrial Kilowatthour Consumption, and Integrated Approaches to Forecasting. To introduce this volume, the symposium's coordinator discusses the background of electric utility forecasting. A separate abstract was prepared for the introductory paper and for each of the 17 presentations.

50224 (EPRI-EA—1035-SR, pp ix-xx) **Background for the electric utility load forecasting symposium.** Crow, R.T. (Electric Power Research Institute, Palo Alto, CA). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

The forecasting of electric utility loads and rates was simple until the Arab oil embargo and plans for capacity increases could be made without concern for serious consequences if the forecasts were in error. Correct forecasting is more complicated and more crucial today, although utilities do not agree on the best methodology. New techniques relying on either the engineering or the econometric approach have been developed, each having its advocates. The most serious problems still to be resolved are concerned with serivce area data, forecasts of regional economic activity, the influence of regulatory and legislative requirements, and the quality of forecasting models. The papers presented at the Electric Power Research Institute symposium address the problems of accurate load forecasting.

50225 (EPRI-EA—1035-SR, pp 1.1-1.91) **Forecasting residential demand for electric energy. Section 1.** Burbank, H.D. (Northeast Utilities, Berlin, CT). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

Reduction in both population growth rate and energy use per customer, as well as changes in residential rate forms, have altered the forecasting of electric power demand for the residential sector. More detailed and explicit demand models are now necessary, with econometric models used for short-run and systems simulation for long-run forecasting. The Economic/Demographic Model is used by Northeast Utilities for short-run forecasts because (1) it is relatively easy and inexpensive to use, and (2) it can capture the business cycle and be coupled with the budget and planning process of corporations. System simulation models are preferred for the long run because of the flexibility their disaggregated nature offers to test alternative scenarios. The development of an adequate data base is one of the major problems confronting utility forecasting. 15 references.

50226 (EPRI-EA—1035-SR, pp 4.1-4.21) **Three methods of forecasting residential loads. Section 4.** Torrance, J.M.; Maxwell, L.C. (Tennessee Valley Authority, Chattanooga). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

The Tennessee Valley Authority (TVA) had evolved its load forecasting from simple trend projections to appliance saturation, and finally, to econometric modeling. Each of these methods is analyzed to evaluate its reasonableness in planning and operating electric utilities when adjusted for the effects of conservation and substitution. The use of alternative methods to evaluate and quantify the factors influencing load growth helps the forecaster to make a positive presentation and the public to understand the process.

50227 (EPRI-EA—1035-SR, pp 5.1-5.13) **Peak-load-forecasting methodology. Section 5.** Fitzpatrick, G.L. (Long Island Lighting Co., Mineola, NY). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

The method used by the Long Island Lighting Company to forecast peak loads is described as it is evolving from a 1974 decision to seek better forecasting than the simple extrapolation from consumption patterns of customer groups that had been used. The present stage of forecasting technique combines econometric modeling and extensive data research on individual major classes of business and specific major appliances. Future kilowatt demand will be affected by federal energy conservation targets, the impact of residential time-of-day rates, and changes in appliance size and use. A comparison of the long-range residential econometric results with those of the physical energy model should prove corroborative.

50228 (EPRI-EA—1035-SR, pp 6.1-6.20) **Forecasting peak demand and load shape for Wisconsin Electric Power Company. Section 6.** Kalscheur, R.J. (Wisconsin Electric Power Co., Milwaukee). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

Prior to 1976, when the Wisconsin Electric Power Company applied for a new construction permit, the utility had relied on simple, low-range demand forecasting. When more explicit and quantifiable justification for the proposed plant was requested, an econometric model was designed that combines statistical monthly peak demand over a 12-year period and quantification of future changes due to conservation, improved end uses, fuel substitution, load management or control, and rate structure reform. Preliminary results of the model appear to be reasonable and are ready to be installed in the computer and tested.

50229 (EPRI-EA—1035-SR, pp 7.1-7.24) **Forecasting peak demand and load shapes. Section 7.** Fuller, K.E. (New York State Electric & Gas Corp., Binghamton). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

The model used for long-range demand forecasting by the New York State Electric and Gas Corporation forecasts kilowatt demand directly rather than kilowatthour consumption; it also forecasts load shapes and other information. The utility decided to concentrate on end use and avoid the straightforward econometric approach (although this method is sometimes used to check accuracy) because the overriding concern was for defensibility. A multivariate regression model was designed based on both temperature-sensitive and base loads to give a daily load profile. The information can be used in planning generation mixes, load management needs, and rate change needs. Strengths and weaknesses of the model are examined, and its success in forecasting load growth and load shape trends are noted.

50230 (EPRI-EA—1035-SR, pp 12.1-12.5) **Load forecasting for the Rural Electrification Administration. Section 12.** Stephens, G.O. (Rural Electrification Administration, Washington, DC). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

As a lending institution for 950 distribution systems, the Rural Electrification Administration (REA) relies on power-requirement studies when it reviews loan applications. REA also makes economic appraisals for pump loads for irrigation users and for all borrowers making their first applicaton. Power-requirement forecasting is based on extrapolated historical adjusted data, such as the MICRO analysis method. An REA forecast depicts the number of future customers and their consumption levels, the total kilowatthour input to the system, percentage losses, annual load factor, and noncoincident demand based on climate. Forecast failures are usually the result of either poor preparation or a poor understanding of the assumptions and limitations of the forecast.

50231 (EPRI-EA—1035-SR, pp 18.1-18.30) **Integrated methodology for forecasting electric system energy and demand requirements. Section 18.** Abromaitis, S.C. Jr. (Gilbert Management Consultants, Reading, PA). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

Gilbert Management Consultants has developed a forecasting methodology useful for long-range system demand and energy requirement forecasts of electric utilities in specific geographic regions. Analytic tools and professional judgment are combined, with total system demand and energy requirements computed as interrelated components of the sum of the separate customer forecasts. The methodology is designed to give utility operators and planners useful and consistent information about their specific service areas. It must be flexible enough to deal with changing conditions and technologies by providing understandable information that can be reviewed and updated. An outline for determining end-use energy needs by customer groups is described.

50232 (EPRI-EA—1035-SR, pp 19.1-19.19) **Integrated approaches to forecasting. Section 19.** Weiss, M. (National Economic Research Associates, Inc., New York, NY). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

Integrated forecasts, combining energy needs for all sectors, face problems of uncertainties and their effect on the quality of the forecast. Identifying the components of uncertainty into conceptual and data problems that can be resolved and separating them from those that cannot be resolved is essential. The author categorized old-fashined, new, and brand-new uncertainties, the latter referring to emerging legislation and regulations. The model of time-of-day rates used to estimate the impact of brand-new uncertainties is described and shown to indicate a method for substantially reducing system peak, although total electricity sales may actually increase.

50233 (EPRI-EA—1035-SR, pp 20.1-20.9) **Portland General Electric Company's integrated forecasting approach. Section 20.** Tennant, R.L. (Portland General Electric Co., OR). Mar 1979.

From EPRI symposium on how electric utilities forecast; New Orleans, LA, USA (7 Dec 1977).

The Portland (Oregon) General Electric Company has updated its forecasting technique to an integrated process in which cycle-month electricity sales and revenue, calendar-month sales, monthly peak demand, and other factors are analyzed separately and integrated. Although several analytic methods are employed, the simultaneous use of econometrics and the company-composite method forms the basis of the forecast. Load surveys of customer habits are made by class to see how economic factors affect end use. A mathematical model uses historical observations to simulate real-world economic relationships and to provide single-point forecasts. The company-composite method breaks down customers into homogeneous groups based on information from customers and utility personnel. The electric energy sales forecast is followed by a monthly revenue forecast, which is converted to a calendar-month and a cycle-month forecast.

50234 R and D benefits: getting down to cases. Whitaker, R. *EPRI J.;* **4**: No. 5, 28-30(Jun 1979).

Utah Power and Light Co. and Pennsylvania Electric Co. executives evaluated the benefits their respective companies realized from membership in EPRI. Allan Hunter reported that Utah Power and Light determined what short-term benefits had resulted from their five-year research expenditures by selecting six projects - two local and four EPRI - that were easily quantified. Both annual savings in 1978 dollars and present worth over the project lifetime were calculared. The expenditures from 1973 to 1977 amounted at about $990,000 annually and UPL realized a saving of $7.4 million in 1978 alone. The projects involved using waste water for agriculture, a helicopter-borne washing system for transmission line insulators, a compact transmission line, a high-intensity ionizer for electrostatic precipitators, ceramic oxide surge arresters for lightning protection, and ice-release coatings for air-break switches. William Verrochi, reporting on benefits of research by Pennsylvania Electric Company, discussed three areas in detail, although nine projects were identified. The three were compact transmission, reducing steam-turbine blade erosion, and the multistream coal-cleaning system. He adds that coal cleaning alone will provide at least a 6% improvement in plant capacity factor. At their Homer City plant, a 1% improvement is worth $1.2 million per year. (MCW)

50235 Integrated model for forecasting system load. Uri, N.D. (Dept. of Energy, Washington, DC). *Appl. Math. Model.;* **3**: No. 1, 37-40(Feb 1979).

This paper integrates the basic Box and Jenkins structure into an econometric system for forecasting system load. Where the estimated autoregressive and moving parameters are constant over the entire period of estimation in the Box—Jenkins models, this paper presents an integrated Box—Jenkins-econometric model that permits variations in the autoregressive and/or moving average parameters when the series is being estimated over a longer period of time encompassing a change in season. The author concludes that this taking account of changes in economic and weather-related variables is superior to a pure Box—Jenkins model. In this paper the data consist of monthly peak system loads for an electric utility.

50236 Cost allocation model for assessing the impact of energy storage technologies upon electric utilities. Giese, R.F.; Holt, L.; Scheithauer, R. (Argonne Natl Lab, Energy and Environ Syst Div, Ill). pp 1018-1029 of Winter simulation conference, 1978. Vol. 2. Hiland, H.J. (ed.). Institute of Electrical and Electronics Engineers; New York, NY (1978).

From Winter simulation conference; Miami Beach, FL, USA (4 Dec 1978).

A computer simulation code has been developed by Argonne National Laboratory to assess the impact of alternative residential heating and cooling technologies upon the electric utility generation, transmission, and distribution systems. Given input information such as plant capacity, forced-outage rates, scheduled maintenance requirements, and economic data for individual generating units, the program uses hourly utility load data together with synoptic weather data to simulate system loads and costs for specified levels of heating/cooling technology penetration. The program performs five categories of calculations: simulation of residential load, aggregation and propagation of loads through the distribution and transmission subsystems, economic dispatch of generating plant, scheduling of plant maintenance, and calculation of optimal generating plant mix. 9 refs.

50237 Brasil - projecoes do mercado de energia eletrica - 1977—1992. (Brazil - forecasting about the market of electric energy - 1977—1992). Rio de Janeiro; ELETROBRAS (Dec 1977). 130p. (In Portuguese).

A forecasting about the market of eletric energy for the period 1977—1992, realized by Department of Market Study (DEME), ELETROBRAS, Brazil, is presented.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 49945, 50266

50238 (DOE/EIA—0180(77)) **Gas turbine electric plant construction cost and annual production expenses. Fifth annual supplement, 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 25 Jun 1979. 134p. P 07/MF A01.

A total of 520 gas turbine electric plants owned and operated by electric utilities produced 28,849 million kWh during 1977, up from the net 1976 production of 23,580 million kWh. The installed capacity of these gas turbine electric plants at the end of 1977 was 47,935 megawatts, up 2.9% from the 46,576 megawatts in 1976. The total installed capacity of the 355 gas turbine electric plants included in this report was 38,585 megawatts at the end of 1977, and their net generation for that year totaled 20,917 million kWh. These plants account for approximately 80.5% of the total installed gas turbine electric plant capacity and 72.5% of the net gas turbine generation in 1977. The 1977 weighted average annual production expenses, including fuel, for the plants included in this report were 37.38 mills per kWh. Of this total, 30.76 mills were fuel costs. The weighted average cost of fuel burned in the 355 plants listed in this report was 218.91 cents per million Btu, but these costs were subject to wide variations. Distillate oil cost increased 14.5% in 1977 from the preceding year, increasing from 235.5 cents pr million Btu at the end of 1976 to 269.7 cents per million Btu at the end of December 1977.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

50239 (DOE/ET/2099—T1(Vol.1)) **Factors affecting the potential of direct load control for non-generating utilities. Final report.** (Gilbert/Commonwealth, Reading, PA (USA)). Apr 1979. Contract EX-76-C-01-2099. 207p. P 10/MF A01.

Several alternatives are available for achieving load management, including direct or voluntary control of customer loads, customer or utility energy storage systems for diurnal load shifting, and expanded interconnection and operation of electric power systems. All of these alternatives are available to the fully integrated (generating, transmitting and distributing) electric utility and the analysis of their effects encompasses the power supply and delivery system. However, the costs and benefits of the alternatives to the fully integrated electric utility are perhaps not so obvious. Therefore, by considering a non-generating utility, this analysis focuses upon the distribution system and wholesale power supply interaction as a step toward an analysis including the power supply and delivery system. This report develops an analysis procedure and discusses some of the relevant factors to be consdered in the application of direct load control for a non-generating utility system. The analysis concentrates on the distribution system only to determine the effect of rates and payback as a result of direct load control. Thus, the study is responsive to the specific needs of the non-generating utility. This analysis of direct load control encompasses the determination of those loads amenable to control, the selection of a suitable one-way communications system to rend control and the estimation of expected benefits and costs. The complementary functions to the application of direct load control such as automatic meter reading via the addition of a bi-directional communications system and voltage control are not included in the analysis but are detailed for future consideration.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 50198

UNCONVENTIONAL SOURCES AND POWER

GENERATION

50240 (CONF-7805161—, pp 3.55-3.63) **Societal impacts of alternative energy sources.** Benveniste, J.; Kamin, J. (Aerospace Corp., Los Angeles, CA). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

Societal impacts of alternative energy sources are first identified and then quantified so that the energy sources can then be objectively compared. The societal impacts considered include financial impacts, environmental impacts, the effects of various governmental policies, and the depletion of natural resources. The impacts are dicussed in terms of the US economy and the world politics. The methodology selected evaluates the net national economic benefits associated with each alternative energy source. In this approach, quantification is achieved by measuring impacts by the common denominator of their dollar values. 5 figures.

50241 (DOE/IA—0002/04) **Joint Egypt/United States report on Egypt/United States cooperative energy assessment. Volume 4 of 5 Vols. Annexes 6—10.** (Department of Energy, Washington, DC (USA)). Apr 1979. 290p. P 13/MF A01.

Annex 6, which investigates the possible hydroelectric resources of Egypt, reveals that presently the only existing sites are on the upper Nile at the High and Aswan Dams. There are 8 sites on the Nile where it is practical to add hydroelectric generation and, of these, only 4 are feasible for immediate construction. There are also pumped-storage sites on the Nile and the Red Sea. There is also the Qattara Depression in the Western Desert which can be utilized for conventional, as well as pumped-storage generation, by bringing water from the Mediterranean Sea to the depression by canal or tunnel. The options were considered for construction of hydro plants to met the electric load growth of Egypt when other forms of energy supply would be integrated into a comprehensive supply pattern. In Annex 7, the prospective use of nuclear energy to meet Egypt's resources (uranium and thorium) to implement a nuclear energy program, and potential effects of the expanded use of nuclear energy are discussed. Annex 8 discusses solar energy (technology descriptions and impacts, solar thermal power, photovoltaics). Also wind power generation, biomass utilization, desalination, solar air conditioning and refrigeration, and cost of power from diesel engines are discussed. Annex 9 covers geothermal potentials in Egypt, discussing resources with temperatures above 180°C; from 150 to 180°C; from 100 to 150°C; and with temperatures below 100°C. Annex 10 discusses the electric power systems in Egypt. The following subjects are covered: existing electric power systems; electrical power facilities under construction or planned for construction by 1985; past and projected growth of electrical energy; distribution; and electrical power system projected from 1985 to 2000. (MCW)

SOLAR

REFER ALSO TO CITATION(S) 49600, 49622, 49630, 49631, 49632, 49633, 49634, 49635, 49636, 49637, 49638, 49639, 49656, 49659, 49726, 49734, 49737, 49758, 49761, 49764, 50147, 50154, 50156, 50160, 50199, 50200, 50201, 50203, 50206, 50207, 50209

50242 (CONF-7805161—, pp 3.25-3.30) **Use of federally owned hydropower to encourage solar energy development.** Hinman, G.W. (Washington State Univ., Pullman, WA). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

A shift of the nation's energy supply to use renewable sources is one of the cornerstones of current administration energy policy. Several renewable energy technologies provide energy on an intermittent basis and, therefore, require auxiliary energy storage, an alternate energy supply, or both. These intermittent sources include wind electrical generation systems, direct solar electric generation, and solar space heating and water heating. The costs of providing energy storage and backup capabilities can greatly affect the economic attractiveness of these technologies. In the Northwest, the electric supply system, with its large hydroelectric component and large storage capacity, is particularly well suited to this backup role. It was determined that an intermittent source of energy would be worth as much as a thermal plant during most of the 1980s and perhaps beyond in this Northwest region. Because of current and future excess-capacity predictions for the area, it is estimated that a subsidy for an intermittent energy source (solar, in this instance) can be justified, based on delaying or avoiding construction of new thermal power plants, between $3 and $12 per square foot installed solar unit. The author suggests to fund the solar subsidies with a surcharge on Federal hydropower.

50243 (CONF-7805161—, pp 3.43-3.45) **Tax incentives: pros and cons.** Savitsky, G.S. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

In an outline format the author discusses the pros and cons of tax incentives versus direct grants to speed the use of solar power. It is concluded that tax incentives have some specific drawbacks not always recognized by their proponents. They do not necessarily do the job better than direct grant programs. They require as much attention as programs that are more obviously regulatory by nature. The burden for these or other incentives must be on the proponents. The costs to the Treasury, i.e., to the taxpayer, must be clearly determined.

50244 (CONF-7805161—, pp 5.3-5.6) **Western regional plan: an incentive for solar energy.** Watson, R.H. (Univ. of Washington, Seattle). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

At the time it was decided to establish the Solar Energy Research Institute it was also decided to establish a regional center to further the commercialization of solar energy. With funding from the Department of Energy, thirteen western states established the Solar Planning Office West (SPOW). From the state's inputs, SPOW, and the state representatives came the Western Regional Plan. Recommended projects were chosen based on several criteria, including: regional applicability and need; complement with national programs; short term payoff (5 years or less); and potential for cooperation between states. The plan itself consists of some forth projects in six programmatic areas: developing solar related data; information; education and training; legal and legislative; technology; and assessment and planning. Technologically, the emphasis was placed on passive and hybrid heating and cooling, water heating, cooling, wind energy conversion, and biomass conversion. The author outlines the Washington state solar energy effort in particular along with the Western Solar Utilization Network. The author felt the creation of a Federal/state infrastructure such as these organizations was very important in providing incentives and removing barriers to solar commercialization.

50245 (CONF-7805161—, pp 5.7-5.13) **State incentives for solar energy use.** Williams, A. (State Senate, Seattle, WA). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

There are a number of actions a state can take to encourage solar energy use. These actions can vary from enactment of simple educational programs to major financial support of research and pilot projects. However, the legislature of the State of Washington has mainly directed its attention to the following three issues: tax incentives, lending of credit, and solar access. The author outlines Washington's experiences in establishing various tax incentives to solar utilization. Most of the tax incentives are directed at homeowners. To alleviate the large initial cost burden of purchasing and installing energy conservation items, the Washington legislature is grappling with constitutional prohibitions of lending of credit by public utilities. Solar access rights is another important issue being discussed in the legislature.

50246 (CONF-7805161—, pp 5.15-5.23) **California experience in solar incentives.** Veigel, J.M. (Solar Energy Research Inst., Golden, CO). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

According to the author, the California energy programs have as their end purpose the modification of societal energy patterns in the provision of energy supply, its transformation, and its eventual end use. Criteria and methods of implementation are outlined that are applicable to establishing other state energy programs. The tax credit incentive to install solar devices in California is reviewed. The final part of the article lists twenty-five solar bills being evaluated by the California Assembly and Senate. A brief summary of the bill's contents and a status report is listed for each.

50247 (CONF-7805161—, pp 5.25-5.29) **New Mexico's proposed state solar plan.** Thompson, C. (New Mexico Solar Energy Inst., Las Cruces). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The state energy plan of New Mexico is being prepared by the New Mexico Solar Energy Institute. The Institute was begun in 1977 by the state legislature to encourage and coordinate solar development at all levels within the state. An analysis of New Mexico's energy use pattern and energy resources allowed the planners to draft a program with attainable, clearly defined objectives for each of four sectors (residential, commercial, agriculture, and industrial) in which action seemed appropriate. The now exist-

ing infrastructure, as well as communications with all interested groups (universities, consumer groups, etc.) will enable New Mexico to increase solar utilization. 4 references.

50248 (CONF-7805161—, pp 5.31-5.76) **Solar energy implementation in advanced industrial societies: problems, solutions, constraints, and strategies.** Lindberg, L. (Univ. of Wisconsin, Madison); Hammarlund, J.R.; Lisse, R.A. Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

In an outline format, the authors discuss the policy imperatives and technological parameters incident in solar development and utilization. Conditions for solar utilization and obstacles to solar implementation are detailed. Numerous positive measures to create conditions for removing those obstacles are presented. Incentives are directed at individuals as well as institutions. An exhaustive look at the technological and institutional constraints is augmented by a look at political, economic, and psycho-social constraints. Again, strategies and insights on the political side of solar implementation are offered. 130 references.

50249 (CONF-7805161—, pp 5.81-5.85) **Education: the key to widespread solar use.** Boleyn, D.R. (Energy Management Consultant, Gladstone, OR). Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

The most important barrier to the widespread use of solar energy is education, according to the author. Many myths, preconceived notions, and prejudices have kept consumers from realizing the benefits of solar use. The primary reasons for education are to encourage the citizen to: (1) spend some of his income on a solar energy concept, and (2) to spend that money wisely so that he maximizes his economic benefits. Because solar energy use lends itself to decentralized, grass-roots application, any education program must appeal to persons with different life styles, levels of education, varying attitudes, and widely differing economic situations. The author feels education should be coupled with any incentive program.

50250 (CONF-7805161—, pp 6.1-6.11) **Review and conclusions.** Feb 1979.

From 1. Seattle workshop on incentives used to stimulate energy production; Seattle, WA, USA (31 May 1978).

This is the final paper in the workshop on incentives to solar development. The workshop was based on the research report entitled An Analysis of Federal Incentives Used to Stimulate Energy Production, PNL-2410. This paper reviews the important points discussed during the final session in a brief but comprehensive list of remarks made by twenty participants. Most of the remarks are short summaries of the participant's contribution to the workshop. One participant presented an overall view of some of the major ideas that emerged from the discussions. Some of the conclusionns based on the report and related discussions are summarized. The conclusions offer comments on future policy and research needed for full implementation of the solar option.

50251 (SERI/TP—35-300) **Solar energy perspectives for public power.** Woodley, N.H. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1979. Contract EG-77-C-01-4042. 23p. (CONF-790685—1). P 02/MF A01.

From The American Public Power Association 1979 national conference; Seattle, WA, USA (19 Jun 1979).

Perspectives on the utilization of solar energy for electricity production and thermal energy utilization by the public are briefly discussed. Wind energy conversion, biomass conversion, solar thermal, OTEC, photovoltaics, and solar heating and cooling are discussed. (WHK)

GEOTHERMAL

REFER ALSO TO CITATION(S) 50266

OTHER

REFER ALSO TO CITATION(S) 49847, 50285

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

50252 (ANL/MHD—79-4) **Technical support for open-cycle MHD program. Progress report, July—December 1978.** Doss, E.D. (ed.). (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 87p. P 05/MF A01.

The support program for open-cycle MHD at Argonne National Laboratory is developing the analytical tools needed to investigate the performance of the major components in the combined cycle MHD/steam power system. The analytical effort is centered on the primary components of the system that are unique to MHD and also on the integration of these analytical representations into a model of the entire power producing system. The present project activities include modeling of the combustor, MHD channel, slag separator, and high-temperature air heater. In addition, these models are combined into a complete system model, which is at present capable of carrying out optimizations of the entire system relative to either thermodynamic efficiency or cost of electrical power. Also, in support of other aspects of the open-cycle program, test plans are developed and facility and program reviews are provided upon request in support of the needs and requirements of the DOE/MHD Division.

50253 **MHD generating system.** Petrick, M.; Pierson, E.S.; Schreiner, F. (to Dept. of Energy). US Patent Application 943,827. 19 Sep 1978. 13p.

Coal combustion gas is the primary working fluid and copper or a copper alloy is the electrodynamic fluid in the MHD generator, thereby eliminating the heat exchangers between the combustor and the liquid-metal MHD working fluids, allowing the use of a conventional coal-fired steam bottoming plant, and making the plant simpler, more efficient and cheaper. In operation, the gas and liquid are combined in a mixer and the resulting two-phase mixture enters the MHD generator. The MHD generator acts as a turbine and electric generator in one unit wherein the gas expands, drives the liquid across the magnetic field and thus generates electrical power. The gas and liquid are separated, and the available energy in the gas is recovered before the gas is exhausted to the atmosphere. Where the combustion gas contains sulfur, oxygen is bubbled through a side loop to remove sulfur therefrom as a concentrated stream of sulfur dioxide. The combustor is operated substoichiometrically to control the oxide level in the copper.

50254 **Several hundred megawatt MHD units.** Pishchikov, S.; Pinkhasik, D.; Sidorov, V. *Veda Tech. SSSR;* **6**: No. 3, 141-146(Jul 1978). (In Czech).

The features are described of the future MHD unit U-25 tested at the Institute of High Temperatures of the Academy of Sciences of the USSR. The attainable thermal load of the combustion chamber is 290×10^6 kJ/m^3.h. Three types of channel were tested, i.e., the Faraday channel divided into sections with modular insulating walls, the diagonal channel without metal body, and an improved Faraday channel with an output of 20 MW. The described MHD generator is equipped with an inverter which transforms direct current into alternating current, continuously adjusts the load from no-load operation to short-circuit connection and maintains the desired electrical voltage independently of the changes in loading. A new technique of connecting and disconnecting the oxygen equipment was developed which considerably reduces the time of start-up and shut-down. Natural gas is used for heating the air heaters. All equipment used in the operation of the MHD generator is remote controlled by computer or manually.

PERFORMANCE AND TESTING

50255 **Power density and electrical efficiency in closed cycle MHD generator with fully ionized seed.** Yamasaki, H.; Shioda, S. (Tokyo Inst. of Tech. (Japan)). *J. Nucl. Sci. Technol. (Tokyo);* **15**: No. 5, 313-322(May 1978).

Effects of a reduced seed concentration on performances of a nonequilibrium MHD generator are investigated by calculating power densities and electrical efficiencies for both Faraday and Hall generators. It is shown that high electrical efficiencies and high power densities are obtained simultaneously by suppressing the ionization instability with reduced seed fractions (10^{-4} -- 10^{-5}) when values of the effective electrical conductivity and the effective Hall parameter recover to above 50% of their ideal ones. Results also indicate that argon is more suitable for a working fluid than helium in the case of a reduced seed concentration.

50256 **Experimental study of long duration MHD generator.** Kashihara, T. *Denki Shikensho Iho;* **41**: No. 5, 327-345(1977). (In Japanese).

Long duration experiments have been performed on the magnetohydrodynamic generator ETL-Mark III for about 250 hours. The insulator wall of generator channel is made of improved

peg developed at the Electrotechnical Laboratory. Two kinds of electrodes are used: (1) flat plate metal electrodes and (2) metal feed electrodes which are principally usable for infinite time by supplying the metal rod according to its consumption. The maximum electric output power obtained is 520 W in the case of the former electrodes and 570 W in the case of the letter. The output power falls down in about 20 hours in the former case, but not in the latter. The experimental results indicate that the insulating wall holds out for about 500 hours, and that the metal feed electrodes are usable for long duration except for a few problems left unsolved.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 50252, 50347

50257 (ANL/MHD—79-8) **MHD heat and seed recovery technology project. Fifth quarterly report, January—March 1979.** Petrick, M.; Tempelmeyer, K.E.; Johnson, T.R. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 42p. P 03/MF A01.

The MHD Heat and Seed Recovery Technology Project at Argonne National Laboratory is obtaining information pertinent to the design and operation of the heat and seed recovery systems downstream of the channel-diffuser and to the seed regeneration processes. The project goal is to supply the engineering data required in the design of components for prototype and demonstration MHD facilities. The present project activities include: (1) assistance to and cooperation with other MHD programs including the Heat Recovery-Seed Recovery facility; (2) studies of the thermochemistry of seed-slag systems; (3) investigations of ceramic and metallic materials for service in the downstream gas systems; (4) small-scale engineering studies of seed-slag deposition; (5) operation of a 2-MW experimental facility for investigations pertaining to the downstream gas system; and (6) evaluation of seed regeneration processes.

DUCT ENGINEERING AND FLUID DYNAMICS

50258 (ANL/MHD—79-10) **GPSAP: general purpose systems analysis preprocessor.** Geyer, H.K.; Sacks, R.A. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 46p. P 03/MF A01.

GPSAP is designed to allow users with little computer experience to carry out complex numerical systems analysis studies quickly and easily. Given a set of precompiled subroutines modeling the behavior of the components and a brief structure describing the way in which these components are linked and/or constrained, the preprocessor constructs a main program to carry out the analysis. The use of a preprocessor approach, coupled with symbolic code words for the standard system-analytic procedures (e.g., vary model parameters, perform parameter sweeps, study sensitivity or constrained optimization, store or retrieve data from file memory), yields great flexibility while maintaining simplicity in both the GPSAP code itself and the input structures used to invoke it. The code was developed over a period of time for the analysis of various types of problems in MHD channel design.

50259 (DOE/NASA/2674—79/1) **Preliminary evaluation of the role of K_2S in MHD hot stream seed recovery.** Bennett, J.E.; Kohl, F.J.; Stearns, C.A.; Fryburg, G.C.; Burkhart, J.A. (Arkansas State Univ., State University (USA)). Mar 1979. Contract FE-77-A-01-2674. 25p. (NASA-TM—79114). Dep. NTIS, PC A02/MF A01.

Results are presented for recent anaytical and experimental studies of the role of K_2S in MHD hot stream seed recovery. The existing thermodynamic data base was found to contain large uncertainties and to be nonexistent for vapor phase K_2S. Knudsen cell mass spectrometric experiments were undertaken to determine the vapor species in equilibrium with $K_2S(c)$. K atoms and S_2 molecules were found to be the major vapor phase species in vacuum, accounting for greater than 99% of the vapor phase. Combustion gas deposition studies using No. 2 diesel fule were also undertaken and revealed that condensed phase K_2SO_3 may potentially be an important compound in the MHD stream at near-stoichiometric combustion.

50260 **Estimate of electric power losses caused by turbulent layer on the wall in the MHD generator.** Losiowski, W. (Akademia Gorniczo-Hutnicza, Krakow (Poland)). *Arch. Energ.;* No. 2, 73-80(1978). (In Polish).

The percentage power losses caused by the existence of the cool layer at the walls of the MHD generator are evaluated. The percentage of losses is equal to the ratio of the power generated in an ideal case less the diminished power by the layer at the walls divided by the power in an ideal case. The influence of channel diameter on the losses magnitude is discussed in the numerical example. The influence of the magnetic field on the layer thickness as well as profiles of the basic parameters in its area are disregarded in the calculation.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 49706

FUEL CELLS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 50263, 50264

50261 (CONF-790213—4) **Commercial applications of molten carbonate fuel cell systems.** Blurton, K.F.; Peterson, J.R. (Institute of Gas Technology, Chicago, IL (USA); General Electric Co., Schenectady, NY (USA)). 1979. Contract EM-78-C-03-1735. 15p. P 02/MF A01.

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

The potential applications of molten carbonate fuel cells are discussed with particular emphasis on the configuration of a dispersed, oil-fueled and a central, coal-fueled base-load power plant. The penetration of these power plants into the utility generation system is described. The status of this technology is reviewed, and the major technology areas currently under investigation are discussed.

PERFORMANCE AND TESTING

50262 (CONF-7810130—3) **Effects of sulfur-containing gases on molten carbonate fuel cell behavior.** Claar, T.D.; Donado, R.A.; Marianowski, L.G. (Institute of Gas Technology, Chicago, IL (USA)). 1978. Contract EM-78-C-03-1735. 16p. P 02/MF A01.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

The effects of sulfur on performance and endurance of molten carbonate fuel cells were investigated using gases containing 10 to 50 ppM H_2S in fuel or SO_2 in oxidant. Performance penalties were quite severe with standard components and losses were predominatly at the anode. Sulfur introduced into the cathode as SO_2 was absorbed by the carbonate electrolyte, most likely as sulfate, transported through the tile, and regenerated at the anode as H_2S and COS. Thermodynamic analyses and pot equilibration tests under highly utilized low-Btu fuel containing 50 ppM H_2S indicate only low levels of alkali sulfide or sulfate are expected on the anode side of the cell. Data have been obtained on the effects of sulfur species on anode materials stability, electrolyte chemistry, component corrosion, and $LiAlO_2$ support particles. Promising cell performance results have been obtained with cobalt-based anodes.

MATERIALS, COMPONENTS, AND AUXILIARIES

50263 (ANL—78-95) **Advanced fuel cell development. Progress report, July—September 1978.** Finn, P.A.; Kinoshita, K.; Kucera, G.H.; Pierce, R.D.; Sim, J.W. (Argonne National Lab., IL (USA)). May 1979. Contract W-31-109-ENG-38. 37p. P 03/MF A01.

This report describes advanced fuel cell research and development activities at Argonne National Laboratory (ANL) during the period July—September 1978. These efforts have been directed toward understanding and improving the components of molten-carbonate-electrolyte fuel cells operated at temperatures near 925 K. The primary focus of this work has been the development of electrolyte structures that have good electrolyte retention and mechanical properties as well as long term stability, and on developing methods of synthesis amenable to mass production. The characterization of these structures and their stability is an integral part of this effort. Synthesis studies have concentrated on the use of low-cost starting material to synthesize γ-$LiAlO_2$, the most stable allotrope of $LiAlO_2$ for the fuel cell conditions. Thermal stability and thermomechanical tests were performed on electrolyte mixtures to determine the effect of cell operating conditions on electrolyte tile longevity. A square cell (10.6 cm) with an electrolyte tile containing γ-$LiAlO_2$ was tested. This tile was reinforced by a wire screen. Post-test examination of this cell after 1000 h of operation showed that the reinforced tile was considerably stronger than un-reinforced tiles. Future cells will utilize tiles with metal screen reinforcement.

50264 (ANL—79-28) **Advanced fuel cell development. Progress report for October—December 1978.** Finn, P.A.; Kinoshita, K.; Kucera, G.H.; Sim, J.W.; Pierce, R.D. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 23p. P 02/MF A01.

Advanced fuel cell research activities at Argonne National laboratory during the period of October—December 1978 are described. These efforts have been directed toward understanding and improving the components of molten--carbonate—electrolyte fuel cells operated at temperatures near 925°K. The primary focus of this work has been the development of electrolyte structures that have good electrolyte retention and mechanical properties as well as long-term stability, and on developing methods of synthesis amendable to

mass production. The characterization of these structures and their stability is an integral part of this effort. Current electrolyte structures are comprised of $LiAlO_2$ particles and an eutectic of Li_2CO_3 and K_2CO_3. The development of procedures for synthesizing $LiAlO_2$ from low cost materials is being pursued. The thermal stability of cold-pressed pellets of $LiAlO_2$ and carbonate eutectic has been tested at 925°K for 22 to 2400 h in air, CO_2, and H_2—CO_2—H_2O. In general, under these test conditions the allotropic form of the $LiAlO_2$ particles remained stable, but their surface area decreased with time of heat treatment. Thermomechanical tests indicated that the strength of $LiAlO_2$ pellets increases with increased particle surface area. Several small (94 cm^2) cells have been operated in which the electrolyte tiles contained alkali carbonates and $LiAlO_2$, primarily the γ allotrope. The performance of these cells was improved by using a high carbonate content (69 vol %) in the tiles and the mechanical strength of the tiles was improved by the use of a metal screen.

APPLICATIONS

REFER ALSO TO CITATION(S) 50143

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

50265 (CONF-7810130—2) **Composition gradients induced by current flow in Li_2CO_3—K_2CO_3 mixtures.** Braunstein, J.; Bronstein, H.R.; Cantor, S.; Heatherly, D.E.; Padova, J.I.; Thomas, T.M.; Vallet, C.E. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 8p. P 02/MF A01.

From The molten carbonate fuel cell workshop; Oak Ridge, TN, USA (31 Oct 1978).

In a molten carbonate fuel cell current flow can cause gradients in the Li/K ratio of a $LiKCO_3$ electrolyte if the cation mobilities are, as in most binary molten salt mixtures, unequal. A one dimensional model predicts 10 to 20 percent composition gradients from estimated values of mobility, activity and diffusivity, none of which is well known. Predictions from a similar model for a system of known properties have been confirmed experimentally by electrolysis—relaxation experiments. The model calculations for carbonates appear consistent with electrolysis—relaxation measurements on fuel cell tiles, but clearly indicate the need for additional specific physical property data, especially the transference number.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 50169, 50177, 50178, 50179, 50180, 50181, 50182, 50183, 50184, 50185, 50186, 50187, 50188, 50189, 50190, 50191, 50192, 50193, 50198

BUILDINGS

REFER ALSO TO CITATION(S) 49491, 49748, 50455

50266 (DOE/ET/27139—1) **Comparison of geothermal energy with coal, oil, and natural gas for selected uses.** Hinman, G.W.; Robertson, J. (Washington State Univ., Pullman (USA). Environmental Research Center). 1979. Contract EY-76-S-06-2221-014. 102p. (RLO—2221-T14-1). P 06/MF A01.

Environmental effects and energy efficiencies for geothermal energy, western strip-mined coal, and eastern underground mined coal applied to space heating, process heat, and electric drive were compared. The measure of an environmental effect is the amount of residual material released to the environment, and the measure of energy efficiency is the second law efficiency of the process involved. The results indicate that geothermal energy efficiencies (second law) are higher than those for coal for all three end uses. The environmental effects for geothermal supply systems are smaller than those for coal in the cases of space heat and process heat and are comparable in the case of electric drive. The optimum allocation of a finite geothermal resource and a finite coal resource between space heat and electric drive has been evaluated from the viewpoint of maximum end use service. The results indicate that, to the extent that locational factors permit, geothermal energy should be used for space heat and coal for electric drive.

50267 **Combustibility of loose fiber fill cellulose insulation: the role of borax and boric acid.** Day, M.; Wiles, D.M. (Natl Res Counc of Can, Ottawa, Ont). *J. Consum. Prod. Flammabil.;* **5**: 113-122(Sep 1978).

The influence of borax and boric acid on the resistance of cellulose insulation to smouldering and flaming combustion has been examined using material treated by a wet application process. Boric acid has been shown to be required at an add-on level of at least 11.6 parts to 100 parts (by weight) of cellulose if resistance to smouldering combustion by cigarette ignition is to be achieved. In order to increase the resistance of the material to flaming combustion, however, it has been shown that borax is required in the formulation. Moreover, in order to maintain the resistance to smouldering combustion it is found necessary subsequently to increase the add-on of boric acid. The relationship between the amount of boric acid required to maintain resistance to smouldering combustion while providing for resistance to flaming combustion with borax is given.

RESIDENTIAL BUILDINGS

50268 (ANL—79-32) **Residential energy-consumption analysis utilizing the DOE-1 computer program.** Arentsen, S.K. (Argonne National Lab., IL (USA)). Apr 1979. Contract W-31-109-ENG-38. 119p. P 06/MF A01.

The DOE-1 computer program is used to examine energy consumption in a typical middle-class household in Cincinnati, Ohio. The program is used to compare energy consumption under different structural and environmental conditions, including various levels of insulation in the walls and ceiling, double and single glazing of windows, and thermostat setback schedules. In addition, the DOE-1 program is used to model the house under three energy distribution systems: a unit heater, a single-zone fan system with optional subzone reheat; and a unitary heat pump. A plant equipment simulation is performed to model the heating and cooling plant currently installed in the house. A simple economic analysis of life-cycle costs for the house is done utilizing the economic simulation portion of DOE-1. Utility bills over the past six years are analyzed to gain an actual energy-use profile for the house to compare with computer results. Results indicate that a 35% savings in heating load may be obtained with addition of proper amounts of insulation as compared with the house with no insulation. The installation of double glazing on windows may save close to 6% on heating load. Thermostat setbacks may result in savings of around 25% on energy consumed for heating. Similar results are achieved with regard to cooling load. Comparison of actual energy consumed by the household (from utility bills) with the computer results shows a 4.25% difference in values between the two. This small percent difference certainly strengthens the case for future use of computer programs in comparing construction alternatives and predicting building energy consumption.

50269 (LBL—9381) **Air-to-air heat exchangers: saving energy and improving indoor air quality.** Roseme, G.D.; Hollowell, C.D.; Meier, A.; Rosenfeld, A.; Turiel, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 8p. (CONF-791009—2). P 02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

Some houses currently built have substantially reduced air infiltration rates to conserve heating and cooling energy use. Indoor air quality problems associated with this large reduction in ventilation air have become apparent. The paper describes the use of mechanical ventilation coupled with heat recovery devices in residential buildings to maintain acceptable indoor air quality and conserve energy. Estimates of energy and peak power savings are given.

50270 (ORO—5552-T1) **Improving the efficiency, safety and utility of woodburning units. Quarterly report No. WB-5, September 15, 1978—December 15, 1978.** Dyer, D.F.; Maxwell, T.T.; Maples, G.; Cooley, I.D.; Woodsen, L.A.; Badr, O.A.; Pruitt, T.M.; Siefien, H.; Kain, R.G.; Vakili, H. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 15 Dec 1978. Contract EC-77-S-05-5552. 62p. P 04/MF A01.

Progress is reported in a research program undertaken to improve the performance, efficiency and safety of wood-burning stoves. Information is included on analytical methods for pedicting performance, development of test methods, results of efficiency tests, and studies of the moisture content in wood. (LCL)

50271 (SIB-T—13-1978) **Sun, air and heat. Experiences from the planning and building of a house with a low energy consumption.** Eek, H. (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1978. 105p. (In Swedish). U 06/MF A01.

The planning and building of an energy saving house well adapted to the environment are described. The certain problems, which appeared due to the new techniques applied in this project, are discussed.

50272 **Michigan energy code: 1 and 2 family dwellings.** Lansing, MI; Michigan Department of Labor (1977). 56p. (NP—23862).

This manual was prepared to aid building code officials in this aplication and interpretation of the Michigan Energy Code as applied to one and two family dwellings. The definitions, figures,

tables, examples and sample calculations included clarify the Code requirements and describe the procedures involved in typical problem solutions. Their use, in conjunction with the rules, should provide a means to determine conformance to the Code. This manual is a condensed version of the Michigan Energy Code and applies only to one and two family dwellings.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

50273 (DOE/TIC—10549) **Public schools energy conservation measures. Report No. 7, Eastridge Elementary School, Lincoln, Nebraska.** (American Association of School Administrators, Arlington, VA). 24 Jan 1977. 54p. P 04/MF A01.

The Federal Energy Administration and the American Association of School Administrators co-sponsored a project called Saving Schoolhouse Energy aimed at determining the cost effectiveness of retrofitting schools, principally with "off-the-shelf" hardware, to affect energy conservation. The results of a field investigation, computer simulation and evaluation of the energy conservation opportunities for an elementary school in Lincoln, Nebraska, are presented. It was estimated that at a cost of $10,000 airflow controls and night setback thermostat controls would have a payback period of six years. (LCL)

50274 (LBL—9380) **Variable ventilation control systems: saving energy and maintaining indoor air quality.** Turiel, I.; Hollowell, C.D.; Thurston, B.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 9p. (CONF-791009—5). P 02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

Mechanical ventilation systems usually provide a fixed quantity of fresh air to a building space based upon the maximum number of people expected to occupy that particular space. When the use of a building space is below its design maximum, the amount of outside air brought into that space can be reduced, thus generally also reducing energy consumption through lower heating and cooling loads. One method of determining the necessary ventilation rate for a particular space is to utilize an air quality detector (e.g., CO_2 or O_2) sensitive to building occupancy and activity load. The output of this detector can in turn be used to control ventilation rates.

50275 (LBL—9382) **Effect of reduced ventilation on indoor air quality and energy use in schools.** Berk, J.V.; Hollowell, C.D.; Lin, C.; Turiel, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 9p. (CONF-791009—4). P 02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

The indoor air quality in an air conditioned California high school has been measured over a variety of ventilation rates ranging from 13.3 ft^3 of outside air per minute for each classroom occupant to approximately 1.5 cfm per occupant. The purpose of this pilot study was to determine the effect of reduced ventilation on indoor air quality and energy use. Parameters measured include outside air supply rate, the occupants' subjective perception of indoor air quality, airborne microbes, carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and ozone in two classrooms, a hall, and outdoors. Carbon dioxide was the only parameter to show a substantial increase in indoor concentration when the ventilation rate was reduced; however, classroom levels still remained far below levels considered to be a health hazard. This study indicates that moderate energy savings are possible at Carondelet High School without significant deterioration of indoor air quality, and that substantial energy savings would be possible in a more severe climatic region.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 50274

50276 (CONF-790808—15) **Evaporative-pad heat transfer performance in a simulated waste-heat environment.** Olszewski, M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 26p. P 03/MF A01.

From 18. ASME national heat transfer conference; San Diego, CA, USA (Aug 1979).

Greenhouse uses of low-grade waste heat have been investigated at the Oak Ridge National Laboratory (ORNL) for a number of years. These investigations have focused on evaporative-pad concepts that are capable of providing both summer cooling and winter heating. As part of this program, performance testing of potential evaporative-pad materials has been performed at ORNL. Results of an experimental investigation of the performance of CELdek packing under simulated waste heat greenhouse conditions are reported. The objective of this study was to characterize the air heating capability of the material as well as its air cooling ability. A cooling efficiency of 85 to 95% was achieved for adiabatic saturation operation. For nonadiabatic saturation conditions, air cooling in excess of 11°C can be achieved if the inlet air wet bulb depression is 15°C. When the wet bulb depression is decreased to 7.8°C, air cooling in excess of 5.6°C is achievable. The results also indicate that CELdek is effective in the heating mode. Energy transport was found to be strongly dependent on water flow rate. Air side pressure drop was found to vary linearly with face velocity and varied from 10.2 to 28.1 Pa over a face velocity range of 1.3 to 2.6 m/sec. The pressure drop was also found to be independent of water flow rate up to the limit (8.4×10^{-4} $m^3/s/m$ of pad length) tested.

50277 (DOE/TIC—10180) **Wisconsin Energy Extension Service implementation plan.** (Wisconsin Energy Extension Service Administration, Madison (USA)). 9 Dec 1977. 46p. P 03/MF A01.

As part of an effort to lower energy consumption levels among individuals and small establishments that use energy, The Energy Extension Service, operating in ten pilot states, has implemented programs which focus on the particular needs of small businesses. These programs have been developed to deliver a range of services to the many different kinds of enterprises which fit into the small business category. The programs currently operating in the ten pilot states are described and examples are given. In Alabama, Auburn University provides information and analyses to test the feasibility of using alternative fuels for small businesses. In Connecticut, the Department of Commerce provides audits to businesses throughout the State. In Michigan, the Department of Commerce, through two contractors, provides seminars to one tenth of the small businesses in southeastern Michigan. In New Mexico, the small business program provides demonstration audits of small businesses using alternative energy sources. In Pennsylvania, EES, in connection with the Pennsylvania State University, provides technical assistance to small businesses throughout the State. In Tennessee, the program provides audits, seminars, and counseling services to small businesses in three of that state's counties. In Texas, the Texas A and M College of Engineering operates an information retrieval system for small manufacturers through a bi-monthly bulletin. In Seattle, Washington, the small business program provides audits to Mom and Pop type businesses in two of that city's neighborhoods. In Wisconsin, the University of Wisconsin provides seminars and audits to hospitality industry businesses. In Wyoming, the small business program provides seminars to firms in the building industry.

TRANSPORTATION

50278 (NP—23855) **Statewide transportation report.** (Idaho Transportation Dept., Boise (USA)). Jun 1978. 29p. TIC.

This report is a brief description of each mode of transporation in Idaho. The State's 831,000 residents occupy 83,557 square miles at a population density of 10 persons per square mile. Its residents and their home area are served by a mix of transportation facilities which include the following: 57,788 miles of public highways, roads, and streets; 2,574 miles of operating railroad lines which accomodate service to two AMTRAK routes as well as freight service; 85 municipally-owned airports; a seaport at Lewiston, upstream terminus of 464 miles of navigable waterways from the mouth of the Columbia at the Pacific Ocean; and 6100 miles of pipeline, of which 5600 miles carry natural gas and 500 miles transport petroleum products, including 80% of the gasoline consumed in Idaho.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 50152, 50600

50279 (NEFOS—1978-2) **Energy balances for different industries.** Koehler, B.; Lundqvist, D. (Aangpannefoereningen, Stockholm (Sweden)). Jan 1979. 71p. (In Swedish). U 04/MF A01.

The quantities used to express the energy balance are discussed as well as how to transform these quantities and how to define the qualitites of different energy conditions. Furthermore, a method which is useful for making energy balances within the industries, is presented.

ENERGY SOURCES

REFER ALSO TO CITATION(S) 49442, 50266

50280 (BNL—50927) **Locational analysis for the aluminum industry.** Isard, W.; Parcels, L. (Brookhaven National Lab., Upton, NY (USA)). Dec 1977. Contract EY-76-C-02-0016. 53p. P 04/MF A01.

A locational analysis for the aluminum industry suggests that its locational pattern is probably even more clear-cut than that of the steel industry. Because the smelting of alumina into aluminum requires a very large amount of electric power, aluminum has become

an industry highly oriented to cheap-power locations. A quick analysis, taking into account present technological and economic conditions, reveals that the potential advantages of the minimum-transport-cost location for an aluminum plant are clearly outweighed by the large power cost savings accruing from locating the plant at a cheap-power location. This holds true even with a fairly small differential in power rates between the two locations.

50281 (ORO—5099-T1) **Energy conservation in the textile industry. Phase I.** Cook, F.L.; Dawkins, J.E.; Brookstein, D.S.; Carter, W.C.; Fulford, R.H.; Lowry, J.F.; Murphy, M.M.; Tincher, W.C. (Georgia Inst. of Tech., Atlanta (USA). Engineering Experiment Station). 1977. Contract EY-76-S-05-5099. 167p. P 08/MF A01.

Energy conservation potential of each major process (batch and continuous) is estimated in this Phase I report. The approach was to gather process energy-consumption data from available literature and selected companies and to develop a production matrix by wet process within the industry. For Phase II, equipment and procedure modifications are being developed to demonstrate energy savings. (MCW)

MATERIALS

REFER ALSO TO CITATION(S) 50281

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 50266

50282 (SAN—2156-T1) **Development of improved corrosion and erosion resistance coatings for gas turbine airfoils. Technical progress report, September 1, 1978—March 30, 1979.** Shen, S. (Airco Temescal Div., Berkeley, CA (USA)). 1978. Contract ET-78-C-03-2156. 37p. P 03/MF A01.

Progress in developing improved hot corrosion- and erosion-resistant coatings for industrial/utility gas turbine engine airfoils is reported. Both metallic coatings of the CoCrAl type with various elements addition and ceramic coating of ZrO_2 (12% Y_2O_3) will be evaluated in a single source evaporation PVD system.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 50284

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 49460, 49855

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 50168, 50460

50283 (ANL/ES—76) **Assessment of Stirling engine potential in total and integrated energy systems.** Marciniak, T.J.; Bratis, J.C.; Davis, A.; Lee, C. (Argonne National Lab., IL (USA)). Feb 1979. Contract W-31-109-ENG-38. 167p. P 08/MF A01.

The development of Stirling engines for stationary power applications in Total Energy Systems is attractive for two main reasons: high potential engine efficiency, and fuel flexibility especially in the use of coal and coal-derived fuels. Total Energy applications are unique in that they offer an option for using fuel energy most effectively on a local basis by recovering the rejected heat from electric power generation to meet thermal requirements within a community. These thermal requirements include space heating, cooling, and hot water service demands. The advantages and disadvantages of large Stirling engines in Total, or Integrated, Energy Systems are discussed and the performance and cost characteristics of such engines are analyzed and compared with the main competitors (diesel engines and gas turbines) for such applications. The comparisons are made through simplified and detailed systems analyses. Lastly, based on the systems studied and intercomparisons of competing technologies, the requirements for the development of a large Stirling engine are outlined along with a suggested developmental program. From this study it is clear that, given the attributes of the competing technologies involved, the main advantage of the Stirling engine lies in its ability to use fuels other than distillates. This attribute must be developed further in order to provide engine technologies which can burn abundant fuels such as coal or coal-derived fuels. Secondarily, the potentially high efficiency of Stirlings would be especially advantageous in applications where a high electrical-to-thermal-energy demand ratio exists.

MUNICIPAL WASTE MANAGEMENT

50284 (COO—4382-1) **Preliminary evaluation of the use of powdered coal as a natural gas substitute for sewage sludge incineration. Final report, June 1—November 30, 1977.** Neufeld, R.D.; Yodnane, P.; Abrams, J.I. (Pittsburgh Univ., PA (USA). Dept. of Civil Engineering). Nov 1977. Contract EY-77-C-02-4382. 72p. P 04/MF A01.

Data was collected from each EPA region, each state environmental protection agency, and certain U.S. cities relative to oil, gas, and electricity usage for purposes of wastewater sludge incineration. At present, in the U.S., 7.2 x 10^{12} Btu of premium fuels are utilized for sludge incineration, 68% of which is from gas and 31.5% from oil. Major urban areas at present utilize 3.5 x 10^{12} Btu/yr of these fuels of which 99.5% is from natural gas. By considering sludge incinerators planned and under construction, it may be expected that by 1980, about 9.1 x 10^{12} Btu of premium fuels will be used for this purpose. If ocean dumping and landfilling of sludge were prohibited, and all major urban areas were to utilize sludge incineration, about 32 x 10^{12} Btu (or 159,000 heating equivalents) of premium fuels would be used for this purpose. Coal may be utilized to replace the premium fuels used for sludge incineration. Powdered coal may be utilized in biological reactors as nucleation sites for bio-floc development resulting in enhanced biological processing efficiency, while the resulting coal—biological sludge mixture may be sent to the sludge incinerator. Powdered coal usage at levels dictated by bio-reactor requirements indicate that the possibility exists to recover surplus coal—sludge generated energy from incineration and that 60 x 10^{12} Btu ofpremium fuel would be up for public use. The total social impact of this incinerator is about 450,000 home heating equivalents of energy, about 77.5% of which is located in major urban areas.

50285 (DOE/CS—0095) **Environmental assessment: Urban Waste Technology Program.** (Department of Energy, Washington, DC (USA). Office of Building and Community Systems). Jul 1979. 108p. P 06/MF A01.

The environmental assessment (EA) of the Urban Waste Technology Program has been prepared in accordance with the applicable Department of Energy (DOE) Regulations for compliance with NEPA, and was carried out in awareness of the Council on Environmental Quality Regulations for NEPA implementation. This document analyzes the environmental impacts of DOE's Urban Waste Technology Program authorized by Congress as part of the Department of Energy Act of 1978 and relates to demonstration facilities for producing desirable forms of energy, including synthetic fuels, from urban waste. The major technologies within the Urban Waste Technology Program have been assessed in accordance with the current state of knowledge of each, as of the publication date of this report, to provide input of environmental considerations into the program decision making process.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 50249

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

TURBINE

50286 (COO—2749-23) **Baseline Gas Turbine Development Program. Twentieth quarterly progress report, October 31, 1977.** Schmidt, F.W.; Wagner, C.E. (comps.). (Chrysler Corp., Detroit, MI (USA)). 31 Oct 1977. Contract EY-76-C-02-2749. 75p. P 04/MF A01.

Progress is reported for a program whose goals are to demonstrate an experimental Upgraded gas turbine powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, compact-size American automobile. Activity during this twentieth program quarter has continued to emphasize development towards correcting power deficiency in the Upgraded Engine. Though no absolute improvements have been realized in this quarter, ssignificant progress has been made in identifying causes, appropriately adjusting original design constraints, and proceeding with corrective designs. Specifically, to reduce endwall and secondary flow losses, a new low velocity compressor turbine inlet duct, and blading both with an increased height and lighter loading is being designed. A large increase in the power turbine annulus is being used to significantly lower blade Mach number and leaving loss. Progress is also being made in uniforming regenerator flow for better heat recovery, and in the development of control system components. A Public Interest Car has been built and has proved effective in communicating overall program benefits and goals. In

the area of advanced engine development, work is now underway towards processing sintered alpha silicon carbide into high temperature turbine stage components.

50287 (COO—2749-39) **Baseline Gas Turbine Development Program. Twenty-third combined quarterly progress report, May 1, 1978—January 31, 1979.** Pampreen, R.C.; Wagner, C.E. (comps.). (Chrysler Corp., Detroit, MI (USA)). 31 Dec 1978. Contract EY-76-C-02-2749. 62p. P 04/MF A01.

Progress is reported for a program whose goals are to demonstrate an experimental Upgraded gas turbine-powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine-powered, compact-size American automobile. This is the concluding progress report for this program; it covers the period from May 1, 1978 to January 31, 1979. The next formal report will be the final report, which is currently in process. Activity during this reporting period has continued to emphasize development towards correcting a power deficiency in the Upgraded Engine. Efforts are also being directed towards reducing fuel usage through improved heat recovery and towards improving the mechanical reliability and control of the engine.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

50288 (ANL/CNSV-TM—9) **Analysis of likely economic effects of commercialization of alternative automobile engines.** Hill, L.G.; McNeil, T.L.; Santini, D.J.; Stenehjem, E.J. (Argonne National Lab., IL (USA)). Sep 1978. Contract W-31-109-ENG-38. 49p. P 03/MF A01.

This study provides an analysis of the likely economic impacts resulting from the introduction of alternative engines for automobiles. To ensure that indirect economic effects were included, the impact analysis system, TECNET, and additional computations were employed. A moderate economic growth scenario was developed as a framework for the economic analysis. Primary impacts were found in fuel and materials input sectors. Smelting of ferroalloy ores, nonferroalloy ores, and fuel refining were found to be primary effects. Mining, transport, and capital financing were identified as secondary impacts. This study does not treat all alternative engine configurations and does not examine the value of the multi-fuel capabilities of the specified alternative engines. The results of this study indicate that additional research on these subjects is desirable.

50289 (DOE/NASA/1040—79/6) **Low-power baseline test results for the GPU 3 Stirling engine.** Thieme, L.G. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Apr 1979. Contract EC-77-A-31-1040. 66p. (NASA-TM—79103). P 04/MF A01.

In support of the Department of Energy's Stirling Engine Highway Vehicle Systems Program, the NASA Lewis Research Center has converted a 7.5-kilowatt (10-hp) Stirling engine to a research configuration in order to obtain data for validating Stirling-cycle computer simulations. The engine was originally built by General Motors Research Laboratories for the US Army in 1965 as part of a 3-kW engine-generator set that was designated the GPU 3 (Ground Power Unit 3). Baseline tests were run to map the engine over a range of heater-tube gas temperatures, mean compression-space pressures, and engine speeds with both helium and hydrogen as the working fluid. Tests were limited to the lower power levels because the original alternator and a resistance load bank were used and they were not capable of absorbing the full engine output power. Test results show that engine output and engine efficiency increased with increasing pressure level. However, the relative gain in power and, particularly, the relative gain in efficiency decreased as pressure increased. The maximum efficiency for a given pressure level was obtained at intermediate speeds. Flow losses caused the efficiency to decrease at high speeds, and conduction losses caused it to decrease at low speeds. The hydrogen power curves were more linear with speed than were the corresponding helium curves - an indication of the lower flow losses associated with hydrogen. The maximum power obtained with hydrogen was 4.48 kW (6.0 hp) at 4.1 megapascals (600 psi) mean compression-space pressure; the maximum power output with helium was 3.92 kW (5.25 hp) at 6.9 megapascals (1000 psi).

50290 (DOE/NASA/1040—79/7) **Stirling engines for automobiles.** Beremand, D.G. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EC-77-A-31-1040. 15p. (NASA-TM—79222). P 02/MF A01.

The automobile is one of the most difficult of engine applications. combining the requirements for low cost mass production with those for high efficiency, low emissions, extensive low part power operation and fast response. The ability of the Stirling engine to meet these requirements utilizing existing and near term technology is assessed. In this assessment the results of recent and ongoing automobile Stirling engine development efforts (Ford Motor Company, MTI/USS/AMG, and others) are reviewed and technology status and requirements are identified. Key technology needs include those for low cost, high temperature (1300 to 1500°F) metal alloys for heater heads, and reliable long-life, low-leakage shaft seals. Various fuel economy projections for Stirling powered automobiles are reviewed and assessed. It is concluded that a 50 to 60% fuel economy (mpg) improvement over a conventional spark ignition engine powered automobile is within the development range of existing and near term technology.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 50292

HYBRID SYSTEMS

50291 (UCRL—50056-78) **Mechanical Energy Storage Technology Project: annual report 1978.** Barlow, T.M.; Crothers, W.T.; Kulkarni, S.V.; Rinde, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 May 1979. Contract W-7405-ENG-48. 61p. P 04/MF A01.

The objectives of the Mechanical Energy Storage Technology (MEST) Project at Lawrence Livermore Laboratory (LLL) are to develop and evaluate MEST and to demonstrate its potential for energy savings in vehicular and stationary systems. Primary emphasis is on flywheel energy-storage systems; other applicable concepts are also considered. The activities reported include: (1) MEST application to electric and hybrid vehicles; (2) MEST application to heat engine vehicles; (3) fiber composite materials characterization; and (4) flywheel rotor technology development. (TFD)

50292 (UCRL—52773(Vol.2)) **Assessment of the applicability of mechanical energy storage devices to electric and hybrid vehicles. Volume II.** Schwartz, M.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1979. Contract W-7405-ENG-48. 85p. P 05/MF A01.

The study assesses the ability of mechanical energy storage devices to offer improvements in the performance of electric vehicles. The power and energy required in a storage device to realize specific improvements upon current and near-term electric vehicle performance specifications are calculated. Candidate mechanical energy storage devices are reviewed. It is concluded that only flywheels and, for some applications, hydraulic accumulators are practical in this context. With respect to each performance specification, data are presented on the vehicle mass fraction of the mechanical energy storage system as a function of its specific energy and the overall vehicle mass. The study indicates that mechanical energy storage devices may or may not improve range, depending on the particular configuration of the vehicle and the driving cycle.

50293 (UCRL—83030) **Vehicular applications of mechanical energy storage—FY79.** Crothers, W.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jul 1979. Contract W-7405-ENG-48. 9p. P 02/MF A01.

The goals of this project are to develop and evaluate mechanical-energy storage technology for application to electric, hybrid, and heat-engine vehicles and to maximize the commercial potential of the technology. Four studies were completed in FY79. Performance improvement related to mechanical-energy storage was the subject of two reports. Continuously variable transmission design was discussed in a third. Elastomeric braking was evaluated in a fourth. Two flywheel/electric systems were fabricated and partially tested. An elastomer-braking system design was initiated. Criteria for a vehicle powered by a flywheel/heat engine were formulated.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 50291

MATERIALS

METALS AND ALLOYS

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 49498, 49773, 50300, 50319

50294 (DOE/ET/2606—4) **Development of automated welding processes for field fabrication of thick-walled pressure vessels: electron beam method. Fourth quarterly report, July 1—September 30, 1978.** Weber, C.M. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). 1978. Contract EF-77-C-01-2606. 26p. P 03/MF A01.

This report is the fourth quarterly report of a project to develop and demonstrate an electron beam welding procedure for welding 8" thick SA 387 Grade 22 Class 2 (2-1/4 Cr—1 Mo) steel. Due to the late arrival of the steel to be used in this project, a six month extension in the completion date has been made. Work is in progress for developing 4-1/2" deep partial penetration electron beam welding procedures. A total of 257 welds have been made to date. Several defects have been encountered and successfully eliminated. The occurrence of a necklace defect, which has been shown to be a cold shut resulting from improper solidification, has not yet been eliminated. It has been observed that the beam oscillation pattern is influential on the behavior of the weld cavity during welding. In the vertical welding position, it has been determined that the use of a welding shoe is required.

50295 Further fields of application for prestressed cast iron pressure vessels (PCIV). Guelicher, L.; Schilling, F.E. (Siempelkamp Giesserei K.G., Krefeld (Germany, F.R.)). pp 1/11 1-15 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The redundancy of the prestressing system of prestressed structures as well as the clear separation of sealing and load-carrying functions of prestressed cast iron pressure vessels offer substantial advantages over conventional welded steel pressure vessels. Because of the temperature resistance of cast iron up to 400°C it is possible to build prestressed pressure vessels commercially as hot-working structures. The compressive strength of cast iron, which is 25 times as high as that of concrete allows for a very compact design of the PCIV. Further specific properties of the PCIV like pre-fabrication of the vessel in the production plant - made possible by a structure assembled from segments - short assembly periods at the construction site etc., may open more fields of application. - PCIV as pressurized storage tanks for the emergency shut down system in nuclear power stations. - PCIV as high pressure vessel for the chemical industry. - PCIV as energy storage. - PCIV for light water reactors. - PCIV as burst protection. It is concluded that the application of prestressed cast iron promises to be successful where either structures with large volumes and high pressures and/or temperatures are required or where aspects of safety allow for efficient use of prestressed structures.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 50311, 50335

50296 (CONF-790236—, pp 146-164) **Grain boundary structure and properties.** Balluffi, R.W. (Massachusetts Inst. of Tech., Cambridge). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

An attempt is made to distinguish those fundamental aspects of grain boundaries which should be relevant to the problem of the time dependent fracture of high temperature structural materials. These include the basic phenomena which are thought to be associated with cavitation and cracking at grain boundaries during service and with the more general microstructural changes which occur during both processing and service. A very brief discussion of the current state of our knowledge of these fundamentals is given. Included are the following: (1) structure of ideal perfect boundaries; (2) defect structure of grain boundaries; (3) diffusion at grain boundaries; (4) grain boundaries as sources/sinks for point defects; (5) grain boundary migration; (6) dislocation phenomena at grain boundaries; (7) atomic bonding and cohesion at grain boundaries; (8) non-equilibrium properties of grain boundaries; and (9) techniques for studying grain boundaries.

50297 (CONF-790236—, pp 185-193) **Subgroup report on grain boundary and interphase boundary structure and properties.** Balluffi, R.W. (Massachusetts Inst. of Tech., Cambridge); Cannon, R.M.; Clarke, D.R.; Heuer, A.H.; Ho, P.S.; Kear, B.H.; Vitek, V.; Weertman, J.R.; White, C.L. . Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

In many high temperature structural applications, the performance characteristics of a materials system are largely controlled by the properties of its grain and interphase boundaries. Failure in creep and fatigue frequently occurs by cavitation, or cracking along grain boundaries. In a few special cases, this failure problem has been overcome by directional alignment of grain and interphase boundaries by various types of metallurgical processing such as directional solidification and directional recrystallization. A good example is to be found in the application of directionally aligned structures in high performance gas-turbine airfoils. However, where fine, equiaxed grain structures are desirable, other methods of controlling grain boundary properties have been developed. Important among these has been the introduction of improvements in primary melting practices, designed to control important impurities. This is of decisive importance because even traces of certain impurity elements present in grain boundaries in high temperature materials can seriously affect properties. Impurities are deleterious and need to be removed. However, in certain cases, (e.g., creep fracture) controlled impurity additions can be beneficial and result in improved properties.

50298 (STU—72-1154/U923) **Influence of microstructure, in particular grain size, on the low cyle fatigue behavior at service temperature of the superalloys X40, UDIMET 500, in 738 LC and INCONEL 739.** Ekbom, R.; Viklund, J.; Johansson, H. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). 21 Nov 1977. 44p. U 03/MF A01.

The microstructure of cast turbine blades can show a wide variation between different castings. The following tests were made to investigate the effect of microstructure on fatigue LCF tests on UDIMET 500, INCONEL 738 LC, X 40 and INCONEL 939 were performed on material with large and with small grain sizes. Crack propagation tests were performed on UDIMET 500, X 40 and INCONEL 738 LC. Different grain sizes were tested. In the LCF tests the large grain size gives superior properties in material INCONEL 739 and X 40 while LCF properties in material UDIMET 500 and INCONEL 738 LC appear to be insensitive to grain size. In the crack propagation tests there is no significant difference in propagation rate between the different grain sizes. Difference in the LCF properties may not be grain sizes but other structural variables. For X 40 the morphology of the carbide phase might be the most important factor. In INCONEL 739 there is a greater probability for interdendritic fracture in the small grain size material and this may be the reason for the difference in the LCF properties.

50299 Crystallographic contributions to the energy problem. Wilkinson, M.K. (Oak Ridge National Laboratory). *Phys. Today;* **32**: No. 7, 32-39(Jul 1979).

Radiation effects, electrolytes, superconductors and catalysts are just four out of the many areas where crystallography is helping to improve existing materials and develop new ones.

50300 Analytical electron microscopy of stainless steel weld metal. Lyman, C.E. (Rensselaer Polytechnic Inst., Troy, NY). *Weld. J. (Miami);* **59**: No. 7, 189s-194s(Jul 1979).

From 60. AWS annual meeting; Detroit, MI, USA (2 Apr 1979).

The technique of analytical electron microscopy in a Scanning Transmission Electron Microscope (STEM) fitted with an x-ray spectrometer is described. This high spatial resolution microanalysis technique is applied to duplex Type 304L stainless steel weld metal. Small inclusions in these steels may be either iron-rich or manganese-rich silicates and may contain small amounts of elements not listed in the normal chemical analysis. Chromium depletion at the delta ferrite/austenite interface was found to be only 0.5 wt % Cr to a spatial resolution of 30 nm. This depletion is unlikely to be the cause of pitting corrosion observed at the δ/γ phase boundary. Cr and Ni composition profiles between delta ferrite regions show that Type 304L tranforms on cooling from delta ferrite to austenite by a massive transformation.

50301 Volume-corrected isomer shifts of transition metal atoms: charge flow and electronegatively scales in alloys. Watson, R.W. (Brookhaven National Lab., Upton, NY (USA)); Bennett, L.H. (National Bureau of Standards, Washington, DC (USA). Inst. for Materials Research). *Hyperfine Interact.;* **4**: No. 1, 806-810(Jan-Feb 1978).

From 4. international conference on hyperfine interactions; Madison, USA (13 - 17 Jun 1977).

It is shown that, once volume effects are suitably accounted for, the isomer shifts of ^{57}Fe, ^{99}Ru, ^{181}Ta, ^{193}Ir, ^{195}Pt and ^{197}Au display common behavior. These are the only transition metals for which there are sufficient data of sufficient resolution to be considered.

50302 Localization and thermal diffusion of positive muons in niobium. Lankford, W.F. (George Mason Univ., Fairfax, Virginia, USA); Birnbaum, H.K. (Illinois Univ., Urbana (USA)); Fiory, A.T.; Minnich, R.P. (Bell Labs., Murray Hill, NJ (USA)); Lynn, K.G. (Brookhaven National Lab., Upton, NY (USA)); Stronach, C.E. (Virginia State College, Petersburg, Virginia, USA); Bieman, L.H. (Wayne State Univ., Detroit, MI (USA)); Kossler, W.J.; Lindemuth, J. (College of William and Mary, Williamsburg, VA (USA)). *Hyperfine Interact.;* **4**: No. 1, 833-837(Jan-Feb 1978).

From 4. international conference on hyperfine interactions; Madison, USA (13 - 17 Jun 1977).

The depolarization rate for spin polarized μ^+ particles implanted into a high purity niobium crystal was studied as a function of temperature. The results were analyzed in terms of nuclear dipolar field inhomogeneity due to the host ^{93}Nb and the local field averaging effect of the muon's motion. An analysis is presented in terms of the structure of the muon wavefunction and parameters characterizing the muon diffusion.

50303 **μi SR diffusion studies at LAMPF.** Heffner, R.H.; Parkin, D.M.; Huang, C.Y.; Hutson, R.L.; Leon, M.; Schillaci, M.E.; Simmons, M.L. (Los Alamos Scientific Lab., NM (USA)); Gauster, W.B. (Sandia Labs., Albuquerque, NM (USA)); Triftshaeuser, W. (Hochschule der Bundeswehr Muenchen, Neubiberg, Germany, F.R.). *Hyperfine Interact.;* **4**: No. 1, 838-843(Jan-Feb 1978).

From 4. international conference on hyperfine interactions; Madison, USA (13 - 17 Jun 1977).

μ^+ SR measurements are reported for Cu and Al over the temperature range from 19K to just below the melting points, together with measurements on V and Ta from 19K to 295K. Al had a much lower depolarisation rate than Cu suggesting that positive muons are not localised in Al at low temperature as in Cu. Depolarisation was absent in Al and Cu at high temperature. V shows a similar depolarisation magnitude as Cu, but with different temperature behaviour. Ta appears to behave like Al.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 49593, 49694, 49997, 50116, 50298

50304 (CONF-790236—) **Time-dependent fracture of materials at elevated temperature.** Wolf, S.M. (ed.). (Department of Energy, Washington, DC (USA). Div. of Materials Sciences). Jun 1979. 204p. P 10/MF A01.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

Separate abstracts have been prepared for items within the scope of the energy data base. (FS)

50305 (CONF-790236—, pp 25-31) **Design considerations for high temperature components in fusion energy systems.** Cramer, B.A. (McDonnell Douglas Astronautics Co., St. Louis, MO). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

First wall and blanket structures present one of the most critical design challenges of fusion reactors. The response and resulting life of these components, operating in high temperature and radiation environments, will have a significant influence on the economy of fusion power. First wall structures form the vacuum wall of the reactor plasma chamber and contain a circulating coolant. Even a very small leak of air or coolant into the chamber will be cause for shutdown of the reactor. Structural analysis studies have been directed at developing an understanding of the response of first wall structures to fusion reactor environments so that direction can be provided to future research efforts. These studies have shown the importance of fatigue crack growth and brittle fracture mechanisms. The growth of flaws to a coolant leak condition have been identified as a critical life determining failure mode. Neutron wall loading has a major effect on wall life due to both the increased rate of radiation damage and higher structural temperatures associated with higher neutron wall loadings. Expanded discussions of the key issues in fusion reactors as they relate to the subject to time dependent fracture at elevated temperature are presented.

50306 (CONF-790236—, pp 32-40) **Liquid-metal fast breeder reactor structural materials design considerations.** Huddleston, R.L. (Oak Ridge National Lab., TN). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

This paper gives a brief overview of the LMFBR, to describe its key components, addresses two key structural problems, reviews high-temperature materials utilized, and places bounds on expected operating conditions. The current status of materials utilization in the LMFBR is summarized as follows: with the exception of the reactor upper internals, design needs for the LMFBR can be met with currently approved Code materials; Inconel 718 can potentially solve the thermal striping problems in the reactor upper internals; temperature, stress-strain levels, and design lifetime of the LMFBR push currently approved Code materials toward their limits of usefulness.

50307 (CONF-790236—, pp 41-59) **Time-dependent fatigue—phenomenology and life prediction.** Coffin, L.F. (General Electric Co., Schenectady, NY). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

The time-dependent fatigue behavior of materials used or considered for use in present and advanced systems for power generation is outlined. A picture is first presented to show how basic mechanisms and phenomenological information relate to the performance of the component under consideration through the so-called local strain approach. By this means life prediction criteria and design rules can be formulated utilizing laboratory test information which is directly translated to predicting the performance of a component. The body of phenomenological information relative to time-dependent fatigue is reviewed. Included are effects of strain range, strain rate and frequency, environment and wave shape, all of which are shown to be important in developing both an understanding and design base for time dependent fatigue. Using this information, some of the current methods being considered for the life prediction of components are reviewed. These include the current ASME code case, frequency-modified fatigue equations, strain range partitioning, the damage function method, frequency separation and damage rate equations. From this review, it is hoped that a better perspective on future directions for basic material science at high temperature can be achieved.

50308 (CONF-790236—, pp 74-87) **Creep mechanisms and constitutive relations in pure metals.** Nix, W.D. (Stanford Univ., CA). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

The mechanisms of creep of pure metals is briefly reviewed and divided into two parts: steady state flow mechanisms, and non-steady state flow mechanisms and constitutive relations. Creep by diffusional flow is now reasonably well understood, with theory and experiment in good agreement. The closely related phenomenon of Harper—Dorn creep can also be understood in terms of diffusion between dislocations. Power law creep involves the climb of edge disloctions controlled by lattice self diffusion. Theoretical treatments of this process invariably give a power law exponent of 3. This natural creep law is compared with the data for FCC and BCC metals. It is suggested that diffusion controlled climb is the controlling process in BCC metals at very high temperatures. Stacking fault energy effects may preclude the possibility that creep is controlled entirely by lattice self diffusion in some FCC metals. The subject of power law breakdown is presented as a natural consequence of the transition to low temperature flow phenomena. The role of core diffusion in this transition is briefly discussed. The mechanisms are presented by which pure metals creep at elevated temperatures. While most of this review deals with the mechanisms of steady state flow, some discussion is devoted to creep flow under non-steady state conditions. This topic is discussed in connection with the development of constitutive equations for describing plastic flow in metals.

50309 (CONF-790236—, pp 88-103) **Deformation mechanisms in cyclic creep and fatigue.** Laird, C. (Univ. of Pennsylvania, Philadelphia). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

Service conditions in which static and cyclic loading occur in conjunction are numerous. It is argued that an understanding of cyclic creep and cyclic deformation are necessary both for design and for understanding creep-fatigue fracture. Accordingly a brief, and selective, review of cyclic creep and cyclic deformation at both low and high strain amplitudes is provided. Cyclic loading in conjunction with static loading can lead to creep retardation if cyclic hardening occurs, or creep acceleration if softening occurs. Low strain amplitude cyclic deformation is understood in terms of dislocation loop patch and persistent slip band behavior, high strain deformation in terms of dislocation cell-shuttling models. While interesting advances in these fields have been made in the last few years, the deformation mechanisms are generally poorly understood.

50310 (CONF-790236—, pp 104-129) **Stress rupture in metals and ceramics.** Raj, R. (Cornell Univ., Ithaca, NY). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

The mechanisms of nucleation and growth of cavities in grain boundaries in metals and ceramics are reviewed. A stress and time condition for nucleation is derived and it is suggested that the junctions of three interfaces such as those formed between inclusions and grain boundaries are the most probable sites for nucleation. Growth of cavities by diffusion also leads to a stress and time condition for failure. Both grain boundary and surface diffusion enter into the fracture equation. In metals, cavities can also grow by power law creep for which a strain and strain rate condition for fracture is obtained. In those ceramic materials, which contain a glass phase in the grain boundaries, the fracture process is dominated by the viscous flow of the glass and the formation of cavities in the glass phase. There is considerable opportunity for new micro-me-

chanical-modelling and experimental work in ceramic materials which could lead to the design of new ceramics with unusual properties such as superplasticity. In metals, the influence of environment, multiaxial stresses, and notches on cavitation are recommended as topics for further research.

50311 (CONF-790236—, pp 130-145) **Plastic creep flow processes in fracture at elevated temperatures.** Rice, J.R. (Brown Univ., Providence, RI). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

Recent theoretical developments on fracture at elevated temperature in the presence of overall plastic (dislocation) creep are discussed. Two topics are considered: stress fields at tips of macroscopic cracks in creeping solids; and diffusive growth of microscopic grain boundary cavities in creeping solids.

50312 (CONF-790236—, pp 165-176) **Deformation aspects of time dependent fracture.** Li, C.Y. (Cornell Univ., Ithaca, NY); Turner, A.P.L.; Diercks, D.R.; Laird, C.; Langdon, T.G.; Nix, W.D.; Swindeman, R.; Wolfer, W.G.; Woodford, D.A. Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

For all metallic materials, particularly at elevated temperatures, deformation plays an important role in fracture. On the macrocontinuum level, the inelastic deformation behavior of the material determines how stress is distributed in the body and thus determines the driving force for fracture. At the micro-continuum level, inelastic deformation alters the elastic stress singularity at the crack tip and so determines the local environment in which crack advance takes place. At the microscopic and mechanistic level, there are many possibilities for the mechanisms of deformation to be related to those for crack initiation and growth. At elevated temperatures, inelastic deformation in metallic systems is time dependent so that the distribution of stress in a body will vary with time, affecting conditions for crack initiation and propagation. Creep deformation can reduce the tendency for fracture by relaxing the stresses at geometric stress concentrations. It can also, under suitable constraints, cause a concentration of stresses at specific loading points as a result of relaxation elsewhere in the body. A combination of deformation and unequal heating, as in welding, can generate large residual stress which cannot be predicted from the external loads on the body. Acceleration of deformation by raising the temperature can be an effective way to relieve such residual stresses.

50313 (CONF-790236—, pp 177-184) **Report of subgroup on high temperature fracture.** Argon, A.S. (Massachusetts Inst. of Tech., Cambridge); Evans, A.G.; Lange, F.F.; Majumdar S.; Raj, R.; Rice, J.R.; Taplin, D.M.R.; Wiederhorn, S.; Wire, G. . Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

Specific areas where research is needed in order to establish a fundamental understanding of the mechanism by which polycrystalline materials fracture at elevated temperature are outlined. A distinction is drawn between steady loading and loading varying in time. The report is classified into six topics: materials and microstructure; fracture under steady and under cyclic loading; irradiation effects; life prediction, and deformation instabilities. The subclassification in each topic is based upon the specific microstructural observations of the phenomena that lead up to fracture. These observations are quite qualitative but this reflects the lack of sophistication of the present understanding of the fundamental mechanisms of fracture at elevated temperatures. The specific phenomena are briefly outlined and recommendations for the type of research most appropriate for their elucidation are made.

50314 (CONF-790236—, pp 194-200) **Subgroup on engineering needs: summary report.** Gupta, G.D.; Blass, J.; Coffin, L.F.; Cramer, B.A.; Hart, E.W.; McClintock, F.A.; Moon, D.M.; Richerson, D. Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

The need to bridge the gap between academic knowledge and industrial application was generally agreed upon in the summary report. Five areas were identified in which future work needs to be performed. These areas refer to metallic as well as ceramic materials and include cumulative damage concepts for crack initiation, environmental studies, more realistic approaches to contitutive equations, design methodology, and fabrication problems in welding, casting, forging, machining, forming, coatings, and powder sintering. (FS)

50315 (CONF-790730—2) **Fractographic study of a thick wall pressure vessel failure.** Canonico, D.A.; Crouse, R.S.; Henson, T.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 20p. P 02/MF A01.

From International Metallographic Society conference; Tamiment, PA, USA (8 Jul 1979).

The pressure vessel described in this paper is identified as Intermediate Test Vessel 1 (ITV-1) and was fabricated of SA508, Class 2 Steel. It was tested to failure at 54°C (130°F). The gross failure appeared to be a brittle fracture although accompanied by a measured strain of 0.9%. Seven regions of the fracture were examined in detail and the observed surfaces were compared to Charpy V-notc. (C/sub v/) specimens of SA508, Class 2 steel broken at temperatures above and below the ductile to brittle transition temperature. Three samples from the vessel were taken in the region around the fatigue notch and four from areas well removed from the notch. All these were carefully examined both optically and by scanning electron microscopy (SEM). It was established that early crack extension was by ductile mode until a large flaw approximately 500 mm long 83 mm wide was developed. At this point the vessel could no longer contain the internal pressure and final rupture was by brittle fracture.

50316 (DOE/ER—0026, pp 2-6) **Hydrogen: for better or for worse.** Warren, J.L. Apr 1979.

From Workshop on analysis of hydrogen in solids; Albuquerque, NM, USA (23 Jan 1979).

The properties of hydrogen in materials are reviewed and the challenges presented by continuing research in this area are discussed.

50317 **Stable crack growth under sustained load.** Schulze, H.D. (Rheinisch-Westfaelischer Technischer Ueberwachungs-Verein e.V., Steubenstrasse 53, D-4300 Essen 1, Germany). pp 1-6 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

All structural components, even class I components of nuclear power plants, contain cracks, although quantity and extent are reduced by a careful finishing and non-destructive testing. The cracks can grow under sustained load, provided that a critical stress intensity factor Ksub(IO) is exceeded. This phenomena occurs even if the influence of corrosion can be excluded. Ksub(IO) is no measure for the extent of stable crack growth. The extent depends on time, stress level and material. Test materials selected for the investigation are the reactor pressure vessel steel 22 NiMoCr 37 (similar to A 533 Grade B class I) and a mild steel St 37. The tests are carried out with CT-Specimens 12,5, 20, 50 and 100 mm thick. Besides the influence of the thickness, that means the stress state, the influences of the initial crack length and the environment (air and water) are investigated, too.

50318 (GA-A—15333) **Recommendation of a triaxial failure theory for graphite.** Tang, P.Y. (General Atomic Co., San Diego, CA (USA)). May 1979. Contract EY-76-C-03-0167-061. 54p. P 04/MF A01.

An extensive literature search has been conducted on the application of triaxial failure theories to an anisotropic brittle solid. This study leads to the conclusion that the strength tensor theory of Tsai and Wu appears most promising for HTGR structural graphites. The reduction of this theory to model the transversely isotropic nature of HTGR structural graphites is presented. The extensions to the ongoing biaxial stress experimental program, needed to provide the additional data required to verify this theory, are defined

50319 (ND-R—38(S)) **Annealing studies of zircaloy-2 cladding at 580-850°C.** Hindle, E.D. (UKAEA, Springfields. Nuclear Power Development Labs.). May 1978. 11p. U 02/MF A01.

For fuel element cladding it is important to determine if prior metallurgical condition combined with irradiation damage can influence high temperature deformation, because studies of such deformation are required to produce data for the cladding ballooning models which are used in analysing loss-of-coolant accidents (LOCA). If the behaviour of all cladding conditions during a LOCA can be represented by, say, the annealed condition, then much experimental work on a multiplicity of cladding conditions can be avoided. By examining the metallographic structure and hardness, the present study determines the time required in the range 580 to 850°C for returning Zircaloy cladding to the annealed condition, so that for any transient, a point can be specified where the material should have annealed. An equation has been derived to give this information.

50320 (NUREG/CR—0824) **Critical experiments, measurements and analyses to establish a crack arrest methodology for nuclear pressure vessel steels. Seventeenth quarterly report, October—December 1978.** Gehlen, P.C.; Hoagland, R.G.; Kanninen, M.F.; Landow, M.P.; Marschall, C.W.; Perrin, J.S.; Popelar, C.; Rosenfield, A.R. (Battelle Columbus Labs., OH (USA)). 1978. 83p. (BMI—2026). P 05/MF A01.

Results of a program seeking (i) dynamic analyses of crack arrest in thermally stressed nuclear pressure vessels, (ii) standardization of a laboratory test method for measuring the crack arrest toughness, and (iii) a crack arrest toughness data base for unirradiated and irradiated nuclear steels and weldments are described.

50321 (UCRL—82614(Rev.1)) **Elastic and plastic properties of uranium dioxide from 5 to 330 GPa.** Gust, W.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jul 1979. Contract W-7405-ENG-48. 5p. (CONF-790709—3(Rev.1)). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

We have measured the shock-compression parameters for UO_2 to 330 GPa. The Hugoniot elastic limit was found to be 5.7 GPa. Evidence for a shock-induced phase transition was observed at about 54 GPa.

50322 Methodology for plastic fracture - a progress report. Wilkinson, J.P.D. (General Electric Co., Schenectady, NY (USA). Research and Development Center); Hahn, G.T. (Battelle Columbus Labs., OH (USA)); Smith, R.E.E. (Electric Power Research Inst., Palo Alto, CA (USA)). pp 1-15 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper describes the progress of a study to develop a methodology for plastic fracture. Such a fracture mechanics methodology, having application in the plastic region, is required to assess the margin of safety inherent in nuclear reactor pressure vessels. The initiation and growth of flaws in pressure vessels under overload conditions is distinguished by a number of unique features, such as large scale yielding, three-dimensional structural and flaw configurations, and failure instabilities that may be controlled by either toughness or plastic flow. In order to develop a broadly applicable methodology of plastic fracture, these features require the following analytical and experimental studies: development of criteria for crack initiation and growth under large scale yielding; the use of the finite element method to describe elastic-plastic behaviour of both the structure and the crack tip region; and extensive experimental studies on laboratory scale and large scale specimens, which attempt to reproduce the pertinent plastic flow and crack growth phenomena. This discussion centers on progress to date on the selection, through analysis and laboratory experiments, of viable criteria for crack initiation and growth during plastic fracture.

50323 Development of a statistically-based lower bound fracture toughness curve (Ksub(IR) curve). Wullaert, R.A.; Server, W.L. (Fracture Control Corp., Goleta, CA (USA)); Oldfield, W. (Materials Research and Computer Simulation, 340 South Kellogg Avenue, Goleta, California 93017, U.S.A.); Stahlkopf, K.E. (Electric Power Research Inst., Palo Alto, CA (USA)). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A methodology has been developed for establishing a well-defined lower bound reference fracture toughness curve for nuclear pressure vessel steels. Reference curves can be developed for a specific concidence limit, stress intensity rate, and material. Alternate indexing procedures can be used depending on the acceptable uncertainty in the indexing parameters.

50324 Stress analysis of pressure vessels and heat exchangers, using finite element techniques. Argyris, J.H.; Koenig, M.; Zschau, E. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Statik und Dynamik der Luft- und Raumfahrtkonstruktionen). pp 1-8 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of the paper is to illustrate the finite element technique when applied to the elastic stress analysis of steel pressure vessels and heat exchangers. The method yields more realistic predictions for the stress distribution than the conventional methods do (as for example the ASME Boiler and Pressure Vessel Codes). The problem which arises when applying the finite element technique to the stress analysis of reactor pressure vessels and heat exchangers is, that the inclusion of the individual tubes and perforations in the supporting tube sheets in an extremely high computational effort. The way in which this problem is solved consists in performing the analysis in two steps. The first step is to analyse the entire reactor pressure vessel or heat exchanger by replacing the perforated plates by solid plates with the same stiffness behaviour and to idealize the tubing by a continuous elastic support. In this paper several finite element models for both the first and the second step, are investigated.

50325 Influence of the stress state on Ksub(Ic). Aurich, D.; Helms, R.; Schmidt, P.; Veith, H.; Ziebs, J. (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). pp 1-9 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

To get a first impression of the influence of stress states of higher multi-axiality than plane strain on Ksub(c) a specimen has been created, in which a bi-axial nominal stress state arises by uniaxial tension. This is attained by tension superimposed by transverse bending stress. The stress distribution without crack was analysed by photoelasticity as well as by finite element method. The results were identical. The stress distribution in the fracture (crack) plane was somewhat inhomogeneous, of course. But the ratio of the stress parallel to the tension axis to that perpendicular to it was max. 1:0.3 with a mean value 1:0.15. Specimens of this type were machined from a rolled sheet of the steel 22 NiMoCr 37, with specimen thickness of about 50 mm. For comparison single-edge notched specimens of the same cross section were prepared from the same material. Fatigue cracks were made following ASTM Recommendations. The fracture mechanics tests were carried out at a temperature of -100°C.

50326 Heavy-Section Steel Technology Program intermediate-scale pressure vessel tests. Bryan, R.H.; Merkle, J.G.; Smith, G.C.; Whitman, G.D. (Oak Ridge National Lab., TN (USA)). pp 1-11 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Eight intentionally flawed thick-walled pressure vessels of ASTM A508 class 2 forging steel or A533, grade B, class 1 steel plate have been pressurized to fracture or leak. Tests of these vessels (990 mm OD, 152 mm wall thickness) permitted the study of fracture behavior of structures under stress states not attainable with conventional testing machines. The test section thickness was chosen in order to provide a test configuration that was essentially full-scale relative to BWR and PWR pressure vessels. Experimental results were used to evaluate and improve methods of fracture analysis that could be used in predicting failure conditions of reactor type vessels.

50327 Use of vessel specific data in estimating brittle fracture probabilities. Jouris, G.M.; Shaffer, D.H. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). pp 6/3 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50328 Enhancement of the quality of the reactor pressure vessel used in light water power plants by advanced material fabrication and testing technolgies. Kussmaul, K.; Ewald, J. (Stuttgart Univ. (TH) (Germany, F.R.). Staatliche Materialpruefungsanstalt). pp 1-24 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The fracture safe assessment of nuclear pressure vessels (RPV) is based upon: (i) an adequate stress analysis, (ii) reliable material characteristics, (iii) acceptable defects sizes. There may arise problems which are related to the inhomogeneity, low toughness and crack phenomena sometimes observed in the base material and heat affected zone (HAZ). Due to this it is difficult and in some respects even impossible to measure the decisive values of (fracture-) toughness and defects. Apart from the significance of those facts for existing RPVs, all efforts were directed to provide a steel which should be non-susceptible to embrittlement and/or cracking in the HAZ and simultaneously yielding in a higher upper shelf toughness of base and HAZ material. These objections were pursued in cooperation with manufacturers, vendors and inspection authorities by the following activities. (i) Detailed investigations to obtain information on: occurrence and size of inhomogeneities and defects, especially stress relief cracking (SCR), toughness properties adjacent to defects; (ii) improvement of: chemical composition, steel making processes, welding procedures, optimum temperature cycle and level for stress relief heat-treatment. In order to solve these tasks it was necessary to develop additional tools and to correlate all partial results which were newly elaborated.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 50296, 50299, 50391, 50393, 50434, 50652

50329 (LA-UR—79-2039) **Contributions of shock-wave physics to high-pressure standards.** Fritz, J.N. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-790709—10). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

Obtaining a primary pressure standard by dynamic means is discussed. The evolution and current state of the copper Hugoniot curve and its reduction to an isotherm is given. Similar, but less complete, considerations are given for tantalum.

50330 Critical-state model for the determination of critical currents in disk-shaped superconductors. Frankel, D.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *J. Appl. Phys.;* **50**: No. 8, 5402-5407(Aug 1979).

A series of experiments has been carried out on the flux trapping and shielding capabilities of a flat strip of Nb-Ti/Cu composite material. A circular piece of material from the strip was tested in a uniform field directed perpendicularly to the surface of the sample. Profiles of the normal component of the field along the sample diameter were measured. The critical-state model was adapted for this geometry and proved capable of reproducing the measured field profiles. Model curves agreed well with experimental field profiles generated when the full sample was in the critical state, when only a portion of the sample was in the critical state, and when profiles were obtained after the direction of the rate change of the magnetic field was reversed. The adaption of the critical-state model to disk geometry provides a possible method either to derive values of the critical current from measurements of field profiles above thin flat samples, or to predict the trapping and shielding behavior of such samples if the critical current is already known. This method of determining critical currents does not require that samples be formed into narrow strips or wires, as is required for direct measurements of J/sub c/, or into tubes or cylinders, as is usually required for magnetization-type measurements. Only a relatively small approximately circular piece of material is needed. The method relies on induced currents, so there is no need to pass large currents into the sample. The field-profile measurements are easily performed with expensive Hall probes and do not require detection of the resistive transition of the superconductor.

50331 Surface structure from angle-resolved secondary-ion mass spectrometry: Oxygen on Cu(001). Holland, S.P.; Garrison, B.J.; Winograd, N. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev. Lett.;* **43**: No. 3, 220-223(16 Jul 1979).

Measured angular distributions for O^- and Cu^+ eje-ated by 1500-eV Ar^+-ion bombardment of chemisorbed oxygen on Cu(001) exhibit anisotropies which vary by greater than a factor of 2. Molecular-dynamics calculations of the ion-impact event agree well with experiment if the oxygen atom is placed in a fourfold coordination site 1.2—1.5 A above the Cu(001) plane. Angle-resolved secondary-ion mass spectrometry is proposed as a powerful new method for the determination of adsorbate positions.

50332 Calculation of the electronic properties of Mo in a first-principles nonlocal-pseudopotential approach. Zunger, A.; Kerker, G.P.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **20**: No. 2, 581-593(15 Jul 1979).

The first-principles nonlocal atomic pseudopotentials previously derived from the density-functional formalism are applied in a self-consistent study of the electronic properties of bulk Mo. Using a mixed-basis representation for the crystalline wave functions, both the localized and the extended features of the electronic states are efficiently described. We show that by use of a completely nonempirical approach the basic electronic properties of the system, such as the band structure, density of states, charge density, and Fermi surface, are favorably reproduced within the pseudopotential formalism.

50333 Core spectra of metals. Swarts, C.A.; Dow, J.D.; Flynn, C.P. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev. Lett.;* **43**: No. 2, 158-161(9 Jul 1979).

By means of model calculations for an independent-electron metal, we calculate the photon absorption and emission spectra of core states, including conduction-electron relaxation. We find an x-ray edge anomaly merging into a spectrum resembling that of screened-exciton theory. Neither of these theoretical limits adequately represents the detailed structure of the exact results.

50334 Extended x-ray—absorption fine structure of small Cu and Ni clusters: Binding-energy and bond-length changes with cluster size. Apai, G.; Hamilton, J.F.; Stohr, J.; Thompson, A. (Research Laboratories, Eastman Kodak Company, Rochester, New York 14650). *Phys. Rev. Lett.;* **43**: No. 2, 165-169(9 Jul 1979).

Extended x-ray—absorption fine-structure measurements have been made on metal clusters of Cu and Ni which were formed by vapor deposition on amorphous carbon substrates. Small clusters of both elements show a substantial contraction of the nearest-neighbor metal-metal distance and an increase in binding energy for the onset of the K absorption edge. The results are explained by the increasing surface-to-volume ratio as the cluster size decreases resulting in a more free-atom—like configuration of the metal atoms.

50335 Does the "triple-q" magnetic structure exist in neodymium?. Moon, R.M.; Koehler, W.C.; Sinha, S.K.; Stassis, C.; Kline, G.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **43**: No. 1, 62-64(2 Jul 1979).

Through neutron polarization-analysis experiments at 9.9 K, we have determined that certain satellites in the neutron diffraction pattern of Nd are not caused by a lattice distortion, but rather by a modulated moment component in the basal plane and perpendicular to b_1. The magnetic structure is thus even more complicated than hitherto proposed, and there is now no direct experimental evidence to support the "triple-q" model.

50336 Flux-flow noise in a Pb/sub 0.8/In/sub 0.2/ superconducting alloy. Thompson, J.D.; Joiner, W.C.H. (Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221). *Phys. Rev., B: Condens. Matter;* **20**: No. 1, 91-104(1 Jul 1979).

An investigation of flux-flow noise in Pb/sub 0.8/In/sub 0.2/ samples is presented. Good fits are obtained for experimental noise spectra using our recent model of fluxoid motion interrupted by pinning centers. A distribution of subpulse times is introduced in accordance with the model, and the data require that longer subpulse times be included when the samples undergo annealing which increases grain size. Since at fixed field the relative distribution of subpulse times does not shift with Lorentz force or fluxoid velocity, we conclude that pinning centers which are effective at interrupting fluxoid motion at one Lorentz force and fluxoid velocity appear to be effective at all forces and velocities in the linear flux-flow region. In our model, the noise at zero frequency, W (0), is no longer simply proportional to the average intrinsic flux bundle size, but includes averages over distances between pinning centers. We refer to the appropriate new quantity as the generalized flux bundle size and we find that this quantity is affected by the sample metallurgy, increasing in proportion to grain size. The generalized flux bundle size also begins to decrease rapidly in the field vicinity of the volume pinning force maximum, and becomes small at H/sub c/2. The data give an indication that there is a shift to shorter subpulse times in the region of the pinning force maximum. The concept of a "flux bundle" is discussed in light of the present results.

50337 Theory of magnetoconductivity induced by superconducting fluctuations in anisotropic bulk and fibrous samples. da Silva, E.Z.; Gyorffy, B.L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **20**: No. 1, 147-158(1 Jul 1979).

We present a calculation of the fluctuation-induced magnetoconductivity σ/sup f/(T,H,θ) for an anisotropic bulk and an anisotropic single fiber superconductor in the dirty limit. The purpose of the exercise is to show that, by measuring the variation of σ/sup f/(T,H,θ) with angle θ and field H, one can easily differentiate between an anisotropic bulk sample and one with fibrous morphology. To illustrate our point we analyze the available experimental data on (SN)/sub x/. Our analysis favors a model according to which this metal consists of thin (~ 150 A) anisotropic fibers.

50338 Lattice-parameter changes due to Au dissolution in Pb. Warburton, W.K.; Moss, S.C. (Physics Department, University of Houston, Houston, Texas 77004). *Phys. Rev. Lett.;* **42**: No. 25, 1694-1697(18 Jun 1979).

A careful measurement of the lattice parameters of pure Pb and a Pb+(0.0918 at.% Au) sample after a quench and equilibrium annealing cycle shows that Au in both monomer and "tetramer" defect states produces lattice contraction with the "tetramer" somewhat remarkably having the larger effect per atom. The observed monomer contraction suggests that the majority site occupancy for Au is substitutional and that the rapid Au diffusion must therefore involve a substitutional-interstitial mechanism.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 49592, 49593, 49688, 49689, 49692, 49693, 49694, 49695, 50300, 50912

50339 (CONF-790236—, pp 7-14) **Time-dependent fracture of materials at elevated temperature for solar thermal power systems.** Gupta, G.D. (Foster Wheeler Development Corp., Livingston, NJ). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

Various Solar Thermal Power Systems are briefly described. The components of solar power systems in which time-dependent

fracture problems become important are identified. Typical materials of interest, temperature ranges, and stress states are developed; and the number of cycles during the design life of these systems are indicated. The ASME Code procedures used by designers to predict the life of these components are briefly described. Some of the major problems associated with the use of these ASME procedures in the design of solar components are indicated. Finally, a number of test and development needs are identified which would enable the designers to predict the life of the solar power system components with a reasonable degree of confidence.

50340 (LBL—9308) **Effect of coal char on the corrosion of 304 SS.** Foerster, T.F.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 106p. P 06/MF A01.

Thesis.

A layer of coal char covering a metal surface affects the sulfur and oxygen partial pressures at the metal surface and the rate and extent of corrosion. Experiments demonstrating the effect of char composition, depth, bulk gas composition and flow rate on the rate of sulfidation are carried out. A simple theoretical model, predicts the concentration profiles and fluxes of the gaseous species in the char. Since coal char contains carbon, the equilibrium oxygen partial pressure is less than 10^{-18} atm. This low oxygen partial pressure prevents the formation of protective oxide scales and, in some cases, leads to the formation of external sulfide scales. The effect of the layer of char on the sulfur partial pressure at the metal surface depends on the composition of the char. If the char contains a large amount of sulfur-rich volatiles, the sulfur partial pressure of the gas in the char and the extent of sulfidation depend on the composition of the volatiles. If the char contains significant amounts of inorganic ash, the sulfur partial pressure of gas in contact with the char is determined by the equilibria of the various reactions between hydrogen sulfide and ash. For both types of char, the pattern and extent of corrosion of samples exposed for short times are essentially independent of the composition of the bulk gas and the thickness of the char layer. If the char does not contain large amounts of ash or all of the ash has reacted, the sulfur partial pressure at the metal surface is determined by the diffusion of hydrogen sulfide through the char layer. In this case the rate of sulfidation is inversely proportional to the thickness of the char layer and proportional to the hydrogen sulfide in the gas.

50341 (SAND—78-1803) **Development of laboratory apparatus dedicated to the study of hydride—dehydride reactions.** Wemple, R.P.; Kass, W.J. (Sandia Labs., Albuquerque, NM (USA); Sandia Labs., Livermore, CA (USA)). Jul 1979. Contract EY-76-C-04-0789. 30p. P 03/MF A01.

Hydrogen-compatible laboratory apparatus has been designed and developed to study hydride—dehydride reactions at elevated pressures and temperatures. The system has operated at pressures and temperatures up to 34 MPa and 550°C during experiments conducted on $LiAlH_4$ and NiZr. Instrumentation incorporated into the system also allows differential thermal analysis and acoustic emission data to be collected as the chemical reactions progress. 13 figures.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 49909, 49938, 50116, 50299, 50321

50342 (BNL—26424) **Direct observation of defects in A15 compounds produced by fast neutron irradiation.** Pande, C.S. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 8p. (CONF-790653—9). P 02/MF A01.

From Superconductivity in d- and f-band metals; San Diego, CA, USA (21 Jun 1979).

The nature of defect or defect complexes produced in superconducting compounds Nb_3Sn, Nb_3Pt, and V_3Si by high energy ($E \geq 1$ MeV) neutron irradiation is investigated by transmission electron microscopy. The newly developed technique of superlattice reflection imaging is used whereby the regions of reduced long range order are directly imaged. Unlike metals these regions were found in general not to collapse into dislocation loops. The size and the volume fraction of these disordered regions are obtained for fluences ranging from 10^{17} neutrons/cm^2 to 3 x 10^{19} neutrons/cm^2. The size ranges from 20A to 60A. Typical volume fraction for 10^{18} neutrons/cm^2 is over 1%.

50343 **Calorimetric study of stage-I self-interstitial-atom interaction energies in platinum.** Jackson, J.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B: Condens. Matter;* **20**: No. 2, 534-542(15 Jul 1979).

The release of stored energy and the change in resistivity in platinum irradiated below 12 K with 16-MeV deuterons were measured continuously during anneals to the end of Stage I at 35 K. The ratio of the rate of energy release to the rate of resistivity recovery was found to increase markedly toward the end of the anneals. This increase is attributed to interactions between self-interstitial atoms which prevent the reactants from reaching vacancies below 35 K. An interaction energy of 0.75 eV/event was derived from the data. This energy may be interpreted as either the pair binding energy or the difference in energy between the interstitial configurations present before and after the interaction.

50344 **Interpretation of the instrumented Charpy test.** Keegstra, P.N.R. (Imperial Coll. of Science and Technology, London (UK)); Head, J.L. (Imperial Coll. of Science and Technology, London (UK). Nuclear Power Group); Turner, C.E. (Imperial Coll. of Science and Technology, London (UK). Dept. of Mechanical Engineering). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The Charpy impact test has the virtue that the test piece is small. Charpy specimens may, therefore, be irradiated in a nuclear reactor and subsequently removed and tested to monitor the irradiation-induced changes of toughness of the pressure vessel steel. However, the interpretation of the test results presents probelms. Historically, measurements of Charpy energy have been used for quality control purposes only, or have been correlated with in-service failures; it has not been possible to determine a fundamental material property from this type of test. The authors have now developed a transient dynamic finite element computer code specifically for crack propagation studies. This paper describes the application of the code to the analysis of the modified Charpy tests. There were two objectives, the first was to obtain a greater understanding of the mechanics of the Charpy test and the second was to explore the possibility of obtaining a fundamental material property from the test.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 49534, 50116, 50145

50345 (LBL—9257) **Microstructure, sintering and strength of polycrystalline SiC.** Sung, M.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 68p. P 04/MF A01.

Thesis.

SiC, an attractive candidate as a high temperature material, sintered with additions of 1% boron and 1% carbon could reach the theoretical density. The roles of these dopants and related sintering mechanism are controversal, but detailed characterization, both physical and spectroscopic has lead to a new model in this work, suggesting that boron and carbon form a boundary phase which is the diffusion path during sintering. The investigation has been done by applying different techniques. No detectable boron segregation was found, and no convincing evidence showing the existence of boundary phase could be obtained. The results thus indicate that SiC is solid-state sintered, no glassy phase exists, and it is not intrinsically unsinterable. The mechanical strength vs temperature behavior has also been investigated. The different behavior between two sets of samples is due to the different microstructure which is probably due to the difference in the impurity (AL) content.

50346 (ORNL/TM—6850) **Chemical flowsheet conditions for preparing urania spheres by internal gelation.** Haas, P.A.; Begovich, J.M.; Ryon, A.D.; Vavruska, J.S. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 73p. P 04/MF A01.

Small, ceramic urania spheres can be prepared for use as nuclear fuel by internal chemical gelation of uranyl nitrate solution droplets. Decomposition of hexamethylenetetramine (HMTA) dissolved in the uranyl nitrate solution releases ammonia to precipitate hydrated UO_3. Previously established flowsheet conditions have been improved and modified at ORNL and have been applied to prepare dense UO_2 spheres with average diameters of 1200, 300, and 30 μm.

50347 **Process for preparing active oxide powders.** Berard, M.F.; Hunter, O. Jr.; Shiers, L.E.; Dole, S.L.; Scheidecker, R.W. (to Dept. of Energy). US Patent 4,140,771. 20 Feb 1979. Filed date 24 Feb 1978. 8p.

PAT-APPL-880,921.

An improved process is described for preparing active oxide powders in which cation hydroxide gels, prepared in the conventional manner are chemically dried by alternately washing the gels with a liquid organic compound having polar characteristics and a liquid organic compound having nonpolar characteristics until the mechanical water is removed from the gel. The water-free cation hydroxide is then contacted with a final liquid organic wash to remove the previous organic wash and speed drying. The dried

hydroxide treated in the conventional manner will form a highly sinterable active oxide powder. The materials have high-temperature applications such as use in MHD generators and wall linings for fusion reactors.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 50299, 50345, 50358, 50359, 50360

50348 (ANL-Trans—1169) **Continuous measurements of the redistribution of oxygen in UO/sub 2+x/ in a thermal gradient.** Ducroux, R.; Fromont, M.; Pattoret, A. (International Atomic Energy Agency, Vienna (Austria)). Jun 1979. Translation of IAEA-SM—236/89. (CONF-790111—6(Trans)). 21p. P 02/MF A01.

From International symposium on thermodynamics of nuclear materials; Julich, F.R. Germany (29 Jan 1979).

An out-of-pile investigation of the redistribution of oxygen in UO/sub 2+x/ to allow a subsequent explanation of the O/U + Pu profiles obtained after quenching in the irradiated fuel was made. The thermal gradients were obtained with an imaging furnace. The focal spot of a surface of 0.5 cm^2 was adjusted to the top of the cylindrical oxide specimen; the cold part was in contact with a Mo furnace, making it possible to maintain a solid-electrolyte miniprobe (ThO_2—Y_2O_3) containing a Fe/FeO chemical standard under isothermal conditions. The miniprobe gave the O activity in the cold zone of the specimens at all times. It was tested by measuring the O potentials of different chemical systems. The experiments were conducted in an atmosphere of Ar purified by electrochemical pumps. The UO/sub 2+x/ specimens were subjected to a moderate thermal gradient of about 300°C/cm to limit evaporation phenomena to the hot zone. After continuous observation of the emf, the specimens were sharply quenched and then cut into sections; the O/U ratio of each section was analyzed. The oxygen follows the thermal gradient significantly even though the annealing time was relatively short and the temperatures were low. Comparison of the results obtained in UO/sub 2+x/ with a computer calculation performed on the basis of solid-phase thermal diffusion for oxygen showed very reasonable agreement.

50349 **Spin freezing in $MnO.Al_2O_3.SiO_2$ glass: a muon spin depolarization study.** Bieman, L.H.; Graaf, A.M. de (Wayne State Univ., Detroit, MI (USA)); Kossler, W.J. (College of William and Mary, Williamsburg, VA (USA)); Fiory, A.T. (Bell Labs., Murray Hill, NJ (USA)); Stronach, C.E. (Virginia State College, Petersburg, Virginia, USA); Lankford, W.F. (George Mason University, Fairfax, Virginia, USA); Lynn, K.G. (Brookhaven National Lab., Upton, NY (USA)). *Hyperfine Interact.;* **4**: No. 1, 861-865(Jan-Feb 1978).

From 4. international conference on hyperfine interactions; Madison, USA (13 - 17 Jun 1977).

A muon spin depolarization study of a 13.3 at.% Mn-glass sample was undertaken because it afforded the unique opportunity to observe the internal magnetic fields at nonmagnetic sites. For the spin polarized μ^+ particles implanted into the Mn-glass, a large residual polarization is observed, suggesting that a chemical reaction takes the muon into a diamagnetic compound instead of forming free muonium. Below 30 K the muon depolarization rate increases gradually with decreasing temperature, indicating the appearance of internal dipolar fields owing to a slowing down of the Mn-spin reorientation rate. The results are consistent with a Neel type model which assumes that the Mn-spins are grouped in magnetically ordered domains below 30 K. These domains undergo superparamagnetic relaxation attributable to their anisotropic coupling to random, local fields.

50350 **Nonlinear analysis of prestressed concrete reactor pressure vessels.** Berg, S.; Loeseth, S.; Holand, I. (Trondheim Univ. (Norway)). pp 1-11 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A computational model for circular symmetric reinforced concrete shell problems is described. The model is based on the Finite Element Method. Non-linear stress-strain constitutive relations are used for the concrete, the reinforcement and for the liner. The reinforcement layers may be of different steel qualities. Each layer may be given a specified prestressing. This can be done at the beginning of the computations or the specific reinforcement layer can be considered inactive until a specified level of loading is reached. Thus, the prestressing procedure may also be analyzed in detail. Bond-slip effects are not accounted for. However, no bond may be assumed for prestressing cables by inserting special reinforcement elements. Several models of prestressed concrete reactor pressure vessels which have been tested up to rupture have been analysed. Analytical (numerical) models for reinforced concrete are also discussed on a more general basis.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 50310, 50313, 50314, 50339, 50345

50351 (CONF-790236—, pp 15) **Design considerations: gas turbines for electric power generation.** Moon, D.M. Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

The gas turbine represents one of the most sophisticated designs from the standpoint of time dependent deformation behavior. The large size of the equipment, which limits the amount of full scale testing, together with the demanding performance requirements and high level of reliability desired places a high degree of emphasis on the high temperature deformation design process. As an example of the various design considerations used in this equipment, a brief overview of the turbine will be given, highlighting the materials, stress, temperatures, and load history experienced by the major components. Particular attention will then be focused on the vane segment design considerations. This component is not only structurally complicated, but experiences steep temperature gradients imposed by internal cooling and large temperature transients during cyclic duty operation which have to be addressed in the design procedure. Based on this discussion the limitations of the current design procedures will be highlighted and the areas requiring additional research inputs will be discussed.

50352 (CONF-790236—, pp 60-73) **High temperature fracture of ceramic materials.** Wiederhorn,S.M. (National Bureau of Standards, Washington, DC). Jun 1979.

From Workshop on time-dependent fracture of materials; Germantown, MD, USA (15 Feb 1979).

A review is presented of fracture mechanisms and methods of lifetime prediction in ceramic materials. Techniques of lifetime prediction are based on the science of fracture mechanics. Application of these techniques to structural ceramics is limited by our incomplete understanding of fracture mechanisms in these materials, and by the occurrence of flaw generation in these materials at elevated temperatures. Research on flaw generation and fracture mechanisms is recommended as a way of improving the reliability of structural ceramics.

50353 **Stress effects in two modified lead zirconate titanate ferroelectric ceramics.** Fritz, I.J. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. 8, 5265-5271(Aug 1979).

Mechanical properties of ferroelectric ceramics with compositions Pb/sub 0.99/Nb/sub 0.02/(Zr/sub 0.95/Ti/sub 0.05/)/sub 0.98/O_3 and Pb/sub 0.97/La/sub 0.02/(Zr/sub 0.92/Ti/sub 0.08/)O_3 have been studied as functions of both hydrostatic pressure and uniaxial stress. Measurements of ultrasonic velocity and sample strains have been made in order to characterize unpoled samples. Both materials have pressure-induced ferroelectric (FE) to antiferroelectric (AFE) phase transitions at ~0.2 GPa of hydrostatic pressure. Under uniaxial-stress conditions two effects are observed: rotation of FE domains and the FE—AFE phase transition. These effects are separately resolved by the measurements, even though they occur in overlapping stress regions. The domain reorientation responses of the two materials appear to be nearly identical, but the FE—AFE transition begins at lower stress levels for the Nb-doped material. This is presumably due to that material transforming into the orthorhombic ($PbZrO_3$) phase, whereas the La-doped material transforms into the tetragonal AFE phase. The phase transition is spread over a broad range of uniaxial stress for each material and is not nearly complete by 0.6 GPa, the highest stress level attainable. Possible implications of the results for shock-wave studies of FE ceramics are briefly discussed.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 49763, 50299, 50348, 50349

50354 **Magnetic- and crystal-field properties of dysprosium dihydrides and trihydrides from ^{161}Dy Moessbauer studies.** Friedt, J.M.; Shenoy, G.K.; Dunlap, B.D.; Westlake, D.G.; Aldred, A.T. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B: Condens. Matter;* **20**: No. 1, 251-256(1 Jul 1979).

The saturation hyperfine magnetic field at the ^{161}Dy nucleus measured with the 26 keV Moessbauer resonance in DyH/sub 2.00/ identifies a Γ_7 crystal-field ground state for the Dy^{3+} atom. This state originates from a cubal surrounding of the Dy^{3+} atom by H^- atoms, in agreement with the hydridic model for rare-earth hydrides. An analysis of the hyperfine parameters and of the Schottky anomaly permits one to obtain the crystal-field parameters W = 0.83 +- 0.03 k and x = 0.24 +- 0.02, and the exchange field H/sub ex/ = 26 +- 5 kOe. DyH_2 exhibits a long-range magnetic order at 3.3 K while between 3.3 and 6 K fairly complex short-range order is observed. A

possible explanation for this behavior is provided. DyH_3 remains paramagnetic down to 1.6 K.

50355 Quantum ferroelectricity in K/sub 1-x/Na/sub x/TaO_3 and KTa/sub 1-y/Nb/sub y/O_3. Hoechli, U.T.; Boatner, L.A. (IBM Zurich Research Laboratory, 8803 Rueschlikon, Switzerland). *Phys. Rev., B: Condens. Matter;* **20**: No. 1, 266-275(1 Jul 1979).

The effect known as ferroelectricity arises when forces between polarizable ions in a solid produce a spontaneous displacement of these ions which results in a lattice polarization below some characteristic (Curie) temperature. Fluctuations in this polarization may be thermally induced as in the case of classical ferroelectrics, or if the Curie temperature is near 0 K, the fluctuations can be due to quantum-mechanical zero-point motion. The term "quantum ferroelectric" is applied to those systems where fluctuations in the polarization result from the zero-point motion. Experimental determinations of variations in the dielectric constant, spontaneous polarization, and elastic compliance as a function of temperature and impurity concentration are reported for K/sub 1-x/Na/sub x/TaO_3 and KTa/sub 1-y/Nb/sub y/O_3, and these results show that the physical properties of quantum ferroelectrics differ from those of classical ferroelectrics in the following ways: First, for a quantum ferroelectric, the transition temperature depends on impurity concentration (i.e., on an effective order parameter) as T/sub c/ proportional (x-x/sub c/)/sup 1/2/, as opposed to T/sub c/ proportional (x-x/sub c/) for the classical case. Second, the inverse dielectric constant varies with temperature as ϵ^{-1} proportional T^2 for the quantum-mechanical case, instead of ϵ^{-1} proportional T. Finally, the distribution of transition temperatures in a given macroscopic sample with a Gaussian impurity concentration distribution is p (T/sub c/) proportional T/sub c/ exp(-αT/sup ts4//sub c/) for the quantum ferroelectric, as opposed to a Gaussian for the classical situation. These results are in agreement with previous theoretical predictions of some of the distinguishing characteristics of quantum ferroelectricity.

50356 Electron-spin relaxation by tunneling states in β-Al_2O_3:Na. Kurtz, S.R.; Stapleton, H.J. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev. Lett.;* **42**: No. 26, 1773-1776(25 Jun 1979).

Spin relaxation measurements on a color center in the conduction plane of β-Al_2O_3:Na reveal an exceptionally fast rate with an anomalous temperature and microwave frequency dependence. The data are quantitatively described by a mechanism involving the coupling of a color center to the phonon-induced relaxation of a nearby localized two-level tunneling state. The required density of such states is nearly the same as that used to explain the low-temperature properties of β-Al_2O_3:Na.

50357 Superconducting and normal state properties of $ErRh_4B_4$ and $LuRh_4B_4$. Woolf, L.D.; Johnston, D.C.; MacKay, H.B.; McCallum, R.W.; Maple, M.B. (Institute for Pure and Applied Physical Sciences, University of California at San Diego, La Jolla, California). *J. Low Temp. Phys.;* **35**: No. 5, 651-669(1 Jun 1979).

Detailed heat capacity measurements of the ternary compounds $ErRh_4B_4$ and $LuRh_4B4$ have been performed between 0.5 and 36 K and in magnetic fields up to 4kG, yielding new information on crystal field effects in these materials superconducting—ferromagnetic reentrant transition in $ErRh_4B_4$. Static magnetic susceptibility data on $LuRh_4B_4$ are presented which allow qualitative conclusions to be drawn regarding the magnitude of exchange enhancement and orbital paramagnetic effects in the $RERh_4B_4$ compounds. The electrical resistivity of $ErRh_4B_4$ has also been determined between 4 K and room temperature.

50358 Magnetic and electronic properties of DyH_2 from ^{161}Dy Moessbauer spectroscopy. Shenoy, G.K.; Friedt, J.M.; Dunlap, B.D.; Westlake, D.G. (Argonne National Lab., IL (USA)). *Phys. Lett., A;* **67**: No. 3, 241-242(7 Aug 1978).

The Moessbauer study of DyH_2 with the ^{161}Dy resonance shows the presence of long- and short-range magnetic ordering below and above 3.3 K respectively. The crystal field splitting is large compared to the exchange field splitting, contrary to previous results.

50359 Theory of nuclear quadrupole interactions in ionic iron-group compounds - role of antishielding effects. Beri, A.C.; Lee, T.; Des, T.P. (State Univ. of New York, Albany (USA)); Sternheimer, R.M. (Brookhaven National Lab., Upton, NY (USA)). *Hyperfine Interact.;* **4**: No. 1, 509-514(Jan-Feb 1978).

From 4. international conference on hyperfine interactions; Madison, USA (13 - 17 Jun 1977).

The authors chose Fe_2O_3 as an example for their analysis. They have developed a method for calculating the induced field gradients in ionic crystals from first principles, and thereby overcome the difficulties associated with antishielding effects that have existed in the past in the theory of nuclear quadrupole interactions in ionic crystals. The results have also shown that the use of parametric choices of antishielding factors taken from the results for free ions (and atoms) is not justified. The authors can, however, physically justify the relative values of the induced gradients they have obtained from their ab initio calculations.

50360 Uranium nitride. A cubic antiferromagnet with anisotropic critical behaviour. Buyers, W.J.L.; Holden, T.M.; Svensson, E.C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.); Lander, G.H. (Argonne National Lab., IL (USA)). pp 239-245 of Neutron inelastic scattering 1977. Vol. 2. Vienna; IAEA (1978).

From International symposium on neutron inelastic scattering; Vienna, Austria (17 Oct 1977).

Highly anisotropic critical scattering associated with the transition at Tsub(N)=49.5K to the type-I antiferromagnetic structure has been observed in uranium nitride. The transverse susceptibility is found to be unobservably small. The longitudinal susceptibility diverges at Tsub(N) and its anisotropy shows that the spins within the (001) ferromagnetic sheets of the [001] domain are much more highly correlated than they are with the spins lying in adjacent (001) sheets. The correlation range within the sheets is much greater than that expected for a Heisenberg system with the same Tsub(N). The rod-like scattering extended along the spin and domain direction is reminiscent of two-dimensional behaviour. The results are inconsistent with a simple localized model and may reflect the itinerant nature of the 5f electrons.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 50912

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 49938, 50116, 50299, 50348

50361 (HEDL-SA—1562-FP) Thermochemical data and its use in modeling chemical behavior in mixed-oxide fuel pins. Gibby, R.L.; Woodley, R.E.; Adamson, M.G.; Johnson, C.E. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-14-2170. 15p. (CONF-790306—22). P 02/MF A01.

From International conference on fast breeder reactor performance; Monterey, CA, USA (5 Mar 1979).

The status of US activities to obtain fuel chemistry data is reviewed. Analytical expressions addressing basic needs of all fuel chemistry models are presented. Fission product concentrations during irradiation, oxygen-to-metal (O/M) at beginning-of-life and at burnup, and the potential in fuel-cladding gap at burnup are described. (FS)

50362 Radiation-induced isotope exchange in vitreous silica. Shelby, J.E.; Mattern, P.L.; Ottesen, D.K. (Sandia Laboratories, Livermore, California 94550). *J. Appl. Phys.;* **50**: No. 8, 5533-5535(Aug 1979).

Irradiation of vitreous silica containing dissolved deuterium gas results in the isotope exchange of hydrogen and deuterium at hydroxyl sites in the glass. This exchange process was studied as a function of dose, dissolved deuterium concentration, and the initial hydroxyl concentration of the specimen. Vitreous silica which did not initially contain any hydroxyl was observed to form considerable quantities of deuteroxyl during irradiation.

COMPOSITE MATERIALS

STRUCTURE AND PHASE STUDIES

50363 Neutron investigation of the dynamical properties of the mercury-chain compound Hg/sub 3delta/ AsF_6. Heilmann, I.U.; Axe, J.D.; Hastings, J.M.; Shirane, G.; Heeger, A.J.; MacDiarmid, A.G. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **20**: No. 2, 751-762(15 Jul 1979).

We present in this paper the results of a detailed neutron scattering investigation at various temperatures of the dynamical properties of the linear-mercury-chain compound Hg/sub 3-delta/ AsF_6. The main emphasis has been put on the nature of the response function of the Hg chains at higher temperatures ($T > \text{or} \simeq 150$ K). The results are analyzed and discussed in terms of new theoretical results obtained by Emery and Axe, and it is found that the behavior of the Hg chains in this temperature region is one-dimensional liquidlike, in accordance with theoretical predictions. Below T/sub c/ = 120 K where three-dimensional long-range order is established among the Hg ions, the transverse phononlike excitations in the Hg chains with displacement along the chain develop a small (~ 0.1 meV) energy gap at finite wave vector. This feature makes it straightforward to demonstrate the absence of elastic scattering in the sheets of scattering from the Hg chains. We have measured at room temperature acoustic AsF_6 sublattice phonons in the Δ (zeta00) and the Λ (00zeta) directions. The observed dispersion slope of the transverse branch along Δ polarized along Λ is about 25% smaller

than that of the transverse branch along Λ polarized along Δ, in apparent disagreement with elasticity theory which predicts both modes to be governed by C_{44}. We show that this behavior can be qualitatively explained by the anisotropic coupling between Hg chains and the host lattice, leading to a much smaller elastic regime in the Λ direction than in the Δ direction.

MECHANICAL PROPERTIES

50364 Finite element analysis of fracture and fracture propagation in concrete structures. Argyris, J.H.; Faust, G.; Willam, K.J. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Statik und Dynamik der Luft- und Raumfahrtkonstruktionen). pp H2/2 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50365 Effects of moisture migration on shrinkage, pore pressure and other concrete properties. Chapman, D.A.; England, G.L. (King's Coll., London (UK)). pp 1-14 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This work investigates the uniaxial migration of moisture in long, upright, limestone concrete cylinders, sealed at the base and sides, and open at the top. The design represents a section through a concrete pressure vessel wall. The cylinders are subjected to a sustained temperature difference between their ends, with maximum temperatures between 105°C and 200°C. Readings of pore pressure, water content and temperature are taken at various positions along the axis of the cylinders. In one cylinder, transverse and longitudinal shrinkage readings are also recorded. The results for the cylinders show that moisture migration is away from the hot face of the specimens causing reduction in both pore pressure and water content values in this region. The moisture migration creates a drying front which moves slowly up the specimens. The rate at which this drying front, moves is influenced by the base temperature, the magnitude of temperature and pressure gradients and the coefficient of permeability of the concrete. Samples taken from the hot side of the drying front show a considerable increase in the coefficient of permeability, and Scanning Electron Microscope photographs of the microstructure show both a break-up and reduction in size of the hydration products. The experiments reported indicate that when the hot inner face temperature of a concrete pressure vessel is increased above 100°C, the drying rate inside the wall increases considerably, However, it is unlikely pressure vessels of the size currently in use will ever completely dry out.

50366 Material law for concrete under multiaxial stress. Geistefeldt, H. (Consulting Engineers Prof. Zerna-Dr. Schnellenbach, Viktoriastrasse, Bochum, Germany, F.R.). pp 1-10 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In this paper a general triaxial set of finite strain-stress relations is derived, which can include a step-by-step way nearly all known factors and curves of material response. The finite constitutive equations representing the behaviour of concrete are related to the main strain-directions. The elastic part, the functions for uniaxial behaviour, those for biaxial response and finally the relation-parts, nonzero only in triaxial stress-state, can be reset separately by suitable functions which have been adjusted to the material response of actual concrete known from special tests. With a new and very short biaxial failure criterion for concrete, which has been stated and compared with test results, the analytic description of the biaxial behaviour of Kupfer's concrete is completed. With some additional assumptions the proposed failure criteria and the strain-stress equations for concrete are extended to the biaxial response of uncracked orthogonally reinforced concrete response.

50367 Constitutive equations for cracked reinforced concrete based on a refined model. Geistefeldt, H. (Consulting Engineers Prof. Zerna-Dr. Schnellenbach, Viktoriastrasse, Bochum, Germany, F.R.). pp 1-9 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Nonlinear numerical methods to calculate structures of reinforced concrete or of prestressed concrete are mostly based on two idealizing assumptions: tension stiffness perpendicular to cracks is equal to the stiffness of reinforcement alone and shear modulus is taken as constant. In real reinforced concrete structures concrete contributes to the tension-stiffness perpendicular to cracks and thus to the global stiffness matrix because of bond action between concrete and reinforcement and shear transfer in cracks is depending on stresses acting in cracks. Only few authors are taking these aspects into account and only with rough semiempirical assumptions. In this paper a refined nonlinear three-dimensional mechanical model for reinforced concrete is presented which can include these effects, hitherto neglected, depending on the given state of stress. The model is composed of three model-elements: component u - uncracked reinforced concrete with perfect bond (stiffness equal to the sum of the stiffnesses of concrete and reinforcement), component r - reinforcement free in surrounding concrete (reinforcement and concrete are having equal normal strains in noncracked directions and equal shear strains), component c - crack-part (shear stiffnesses in cracks is equal to the sum of shear stiffnesses of the reinforcement mesh, interface shear transfer and dowel action in cracks).

50368 Steel fibre concrete, a safer material for reactor construction - a general theory for rupture prediction. Rammant, J.P.; van Laethem, L.; Backx, E. (Louvain Univ. (Belgium)). pp 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The effect of steel fibre reinforcement on the mechanical behaviour of concrete reactor structures is studied. It is shown that this material leads to a higher safety factor for highly stressed concrete structures like prestressed concrete pressure vessels. The reinforcement of concrete with short steel fibres results clearly in a fundamental change of the material properties. The study comprises basic experiments, the elaboration of an expression of the material laws, the development of a general computer program and the comparison of computational results with more elaborate experiments.

50369 Experimental verification of creep analyses for prestressed concrete reactor vessels. Aoyagi, Y.; Abe, H.; Ohnuma, H. (Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Civil Engineering Lab.). pp 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this study was to clarify which of the various analytical methods to evaluate the effect of creep on the behaviour of prestressed concrete reactor vessels is most suitable, in view of the comparison with experimental creep data based on the tests of prestressed and reinforced concrete members subjected to long term temperature gradients. The main conclusions within the limit of experiments are as follows: (1) First, experiments were made to determine the properties of concrete under the environmental conditions similar in a operating PCRV. (2) Experimental investigations were carried out in which prestressed concrete beams, hollow cylinders and a full scale model (outside diameter 3 m, external height 4 m, and wall thickness 0.5 m) were subjected to long term temperature gradients under the similar restraining conditions as in the walls of PCRV. (3) Various analytical methods such as effective modulus, rate of creep, superposition etc., have been used to calculate creep strains in prestressed concrete members for PCRV. It was made clear, however, that these methods could not always give a realistic prediction for creep behaviours of concrete members especially in such stage as initial heatup of PCRV, when concrete undergoes fairly wide variation of temperature. The authors proposed a new method of creep analysis based on the theory of strain hardening, which assumes that accumulated creep at a given time influences the creep after that. The experimental and calculated results agreed fairly well. Further, this method was incorporated in the finite element creep analysis for the prestressed concrete hollow cylinder and the full scale model.

50370 Three-dimensional nonlinear analysis of multicavity prestressed concrete reactor vessels. Cheung, K.C.; Young, R.C. (General Atomic Co., San Diego, CA (USA)). pp H3/6 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

50371 Direct method of structural analysis for creep in heated concrete structures. England, G.L. (King's Coll., London (UK)); Macleod, J.S. (Health and Safety Executive, London (UK)). pp 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Time-dependent stress analyses of massive concrete structures are often complex and costly. Here a method of calculation is presented which is direct, approximate to any desired degree, and economic if necessary: a compromise between cost and accuracy being within the control of the analyst or designer. Examples are

presented to illustrate both the nature and the accuracy-dependence of the approximations. To demonstrate that the approximate methods can produce solutions of good engineering accuracy, a through-the-wall section of a PCPV is considered in a simple restrained example. The stresses used are those which would be computed normally, using an elastic procedure, for any real problem, and correspond to the thermal stresses only, and the difference between the total initial elastic solution and the limiting steady-state stress solution resulting from differential thermal creep. Solutions are presented for analyses in which both self-equilibrating distributions have been used and these are compared with cases where one distribution only is incorporated. Similar comparisons are made for a plane stress example where a two-dimensional time variation of the stresses exists.

50372 Design and analysis of multicavity prestressed concrete reactor vessels. Goodpasture, D.W.; Burdette, E.G. (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering); Callahan, J.P. (Oak Ridge National Lab., TN (USA)). pp 1-15 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A critical state-of-the-art review of multicavity Prestressed Concrete Reactor Vessel (PCRV) design and analysis practices is presented. Included are discussions of basic design concepts, the behavior of liners and penetrations, and the various tests required and/or employed to demonstrate acceptance of new vessel geometries and innovations. The influences of design codes such as the ACI/ASME Section III, Division 2 and BS 4975, and the various analysis methods are evaluated. Elastic, inelastic, and time-dependent analysis techniques are in a much more advanced stage of development than the constitutive equations that are essential to the satisfactory use of these techniques. The need also exists for development of systematic, methods for calculating ultimate strengths of multicavity vessels to replace the existing practise that is based on simple experimental methods and empirical analyses such as the 'cryptodome' method. Tests are conducted on liner plates, liner anchorage systems, and cooling tubes to provide justification for design practice. These tests are reviewed together with the seven methods of analysis used in the design of anchorage systems. Similarities and differences in functional requirements and design of linear systems for PCRVs and containments are discussed together with the appropriate design code criteria. The adequacy and economy of present liner systems are reviewed and possible future modifications in design practice suggested.

50373 Thin walled PCRV for urban district heating reactors. Hannus, M. (Finnatom, Helsinki). pp 1-12 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The four Swedish and Finnish Companies, AB ASEA-ATOM, AB ATOMENERGI, OY FINNATOM AB and The Technical Research Centre of Finland VTT have just finished a 1.5 year co-operation for a preliminary design of a small single purpose urban district heating reactor. As a reference case a 200 MWt reactor in an underground rock cavity was designed. The PCRV concept adopted for the study is described. As a background a short presentation of design philosophy is given. Because of the urban siting extreme safety requirements were foreseen. For this reason the traditional redundance based reactor safety has been complemented by certain inherent safety features. One of such is that a sufficient quantity of water to cool the reactor for at least 24 hrs is enclosed inside a prestressed concrete vessel housing the reactor. A special presetressing design was chosen to allow access for control of the tendons at reactor hall floor plane. The lid consists of a circular large diameter prestressed concrete flange and a thin inverted dome of reinforced concrete. A progressive failure of the lid was verified in a hypothetical overpressure case and in a case with postulated failure of all prestressing tendons. The calculaticnal failure pressures were 3.0 and 1.0 times the design pressure 7 bar (overpressure). The ultimate load carrying capacity could effectively be ruled by reinforcement. The study demonstrated the feasibility of the proposed prestressing method and lid design at reasonable costs within the actual low pressure interval.

50374 Creep analysis of boiler-podded PCPV by the method of sliced substructures. Kawamata, S. (Tohoku Institute of Technology, Nagamachi-Koeji, Japan); Akiyama, H. (Shimizu Construction Co. Ltd., Tokyo (Japan)); Kuroda, T. (Electric Power Development Co. Ltd., Tokyo (Japan)). pp 1-13 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The authors developed an approximate method of three-dimensional stress analysis for boiler-podded PCPV, 'the method of sliced substructures', in which the system stiffness matrix in the finite element form is formed as the combination of the stiffness representing the axi-symmetric component of resistance and the one representing the two-dimensional resistance of horizontally sliced layers of PCPV. The elastic analysis of an actual PCPV revealed that the new method could reduce the computing time to the order of 1/10 of the ordinary full three-dimensional finite element analysis while maintaining enough accuracy. The final degrees of freedom for the system equations are equal to those of the corresponding axi-symmetric problem for a PCPV having the configuration of a solid of revolution. The present paper applies the same method to the time-dependent creep analysis of the boiler-podded PCPV, in which the need for improvement of computational efficiency is more urgent because numerous steps of elastic analysis have to be repeated. As a numerical example, an actual PCPV for HTGR was analysed.

50375 Design of bonded reinforcement for thermal stresses in prestressed concrete reactor vessels. Kotulla, B.; Hansson, V. (STRABAG BAU-AG, Postfach 211120, Koeln, Germany, F.R.). pp 1-12 of Structural mechanics in reactor technology. Vol. G. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977). (In German)

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper deals with examples of thermal loadings where instationary growth of tensile zones and redistribution of stresses by cracking are of importance. Temperatures produce, in addition to prestressing and internal pressure, the most important stresses in a prestressed concrete reactor pressure vessel. Characteristic of thermal stresses is that they are influenced to a large extent by creep of concrete and that they influence stress redistributions by temperature dependent creep data. The discussed stress states with tensile stress states produced by temperature changes and creep redistribution due to temperature dependent creep show that calculations performed for stationary states without taking into account cracking of the concrete are generally very conservative for the design of the reinforcement.

POLYMERS AND PLASTICS

PHYSICAL PROPERTIES

50376 Low-temperature thermal conductivity of polyethylene. Bhattacharyya, A.; Anderson, A.C. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana: Champaign, Urbana, Illinois). *J. Low Temp. Phys.;* **35**: No. 5, 641-649(1 Jun 1979).

The thermal conductivity of polyethylene is linear in temperature from ~0.6K to below 0.03 K. This behavior can be explained by the scattering of thermal phonons of wavelength λ from the lamella of thickness H when $H<\lambda$.

DEGRADATION AND EROSION

REFER ALSO TO CITATION(S) 49766

OTHER MATERIALS

50377 (UCRL—82126) **Electrical conductivity of shocked water and ammonia.** Mitchell, A.C.; Kovel, M.I.; Nellis, W.J.; Keeler, R.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Jul 1979. Contract W-7405-ENG-48. 5p. (CONF-790709—7). Dep. NTIS, PC A02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

The electrical conductivity of shocked H_2O was measured between 30 to 60 GPa and the conductivity of shocked NH_3 to 28 GPa.

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 49446, 49643, 49687

50378 (UCRL—82360) **Feasibility of glass processing by precision machine technology.** Sanger, G.M.; Baker, P.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1979. Contract W-7405-ENG-48. 12p. (CONF-790510—3). P 02/MF A01.

From SPIE electro-optical technical symposium and workshop; Huntsville, AL, USA (22 May 1979).

As early as 1927, methods of rendering glass and glassy materials more susceptible to mechanical destruction have been investigated. Considerable literature was published in the fields of diamond drilling, the scribing and identing of glass as well as other nonmetallic materials. Little significant progress has been made in either determining the conditions under which this can be accom-

plished or any sound description of the underlying mechanisms. This literature led some months ago, to attempt to apply these concepts to the possibility of applying precision machine technology and diamond turning to processing glass used in optical applications. Initial findings indicate that material can be removed from glass components without large tool wear, and that experiments relating surface character to machine parameters reveal near theoretical surfaces in the machined area. Criteria for determining what constitutes a machined optical quality or easily polished surface is described. Experimental results relating machined surface character to machine parameters are presented.

STRUCTURE AND PHASE STUDIES

50379 (BNL—25984) **Neutron scattering studies of pretransitional phenomena in structural phase transformations.** Shapiro, S.M. (Brookhaven National Lab., Upton, NY (USA)). Mar 1979. Contract EY-76-C-02-0016. 34p. (CONF-790219—10). P 03/MF A01.

From AIME annual meeting; New Orleans, LA, USA (18 Feb 1979).

Materials exhibiting structural phase transformations are well known to possess pretransitional phenomena. Below the transition temperature, T/sub c/, an order parameter appears and the pretransitional effects are associated with the fluctuations of the order parameter. Neutron scattering techniques have proved invaluable in studying the temporal and spatial dependence of these fluctuations. $SrTiO_3$ is the prototypical example of a structural phase transformation exhibiting features observable in other transformations such as martensitic and order-disorder. The experimental evolution of the understanding of the phase transformation in $SrTiO_3$ will be reviewed and the features observed will be shown to typify other systems.

50380 (GA-A—15291) **Round robin optical measurements of preferred orientation in nearly isotropic pyrocarbon.** Stevens, D.W. (General Atomic Co., San Diego, CA (USA)). Jun 1979. Contract EY-76-C-03-0167-061. 100p. P 05/MF A01.

The results of round robin optical measurements of preferred orientation in pyrocarbon were obtained from seven laboratories (participants). The data were obtained from samples transferred from participant to participant in conventional round robin fashion. Straight lines were fit to this data from each participant pair, and a seven-dimensional hyperline fit was made through the data common to all seven participants. The correlations between participant pairs suggest significantly different degrees of mutual correlation for differen' participants. The data from some participants are shown to correlate significantly better with the rest of the data than data from other participants. The significance of these results for the high-temperature gas-cooled reactor is discussed.

50381 **Interface recombination of charge carriers in bicrystals.** Leong, J.Y.; Yee, J.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **50**: No. 8, 5345-5347(Aug 1979).

A standard photoconductance measurement is suggested for determining the intergrain recombination velocity of excess charge carriers in a bicrystal. Analysis of the bicrystal photoconductance shows two important effects: First, if the grain size is much larger than the diffusion length, the excess-carrier lifetime in a polycrystalline material will be indistinguishable from that in a single crystal with the same bulk and surface properties. Second, as the intergrain recombination velocity increases, its effect tends to saturate.

50382 **Self-consistent calculation of the electronic structure of the (110) GaAs-ZnSe interface.** Ihm, J.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **20**: No. 2, 729-733(15 Jul 1979).

The abrupt (110) interface of GaAs-ZnSe is studied using the self-consistent pseudopotential method. No interface states are found in the fundamental gap, but interface states do split off from bulk states in some other regions. The band-edge discontinuity found in the present calculation does not satisfy the simple electron affinity rule; the calculated discontinuity of the conduction-band minima is 0.7 eV compared with the electron-affinity difference of 0.02 eV. The role of ionicity in the electronic structure of the interface is discussed.

50383 **Wall-induced pretransitional birefringence: A new tool to study boundary aligning forces in liquid crystals.** Miyano, K. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **43**: No. 1, 51-54(2 Jul 1979).

A wall-induced birefringence in a nematic liquid crystal above the nematic-isotopic phase transition point has been observed for the first time. It is expected that this phenomenon will provide a useful tool to study the nature of aligning forces at liquid-crystal—solid interfaces.

50384 (UCRL-Trans—11480) **Rhombic modification of beryllium fluoride.** Korenev, Yu.M.; Simanov, Yu.P.; Novoselova, A.V. Translated from *Dokl. Akad. Nauk SSSR;* **147**: No. 4, 846-848(1962). 7p. P 02/MF A01.

A modification of BeF_2 similar in structure to low-temperature quartz was detected in a study of the system NaF—BeF_2. The modification has a hexagonal lattice with the constants a = 4.72 kKh, c = 5.18 kKh, and c/a = 1.10. Another modification exists in the range 680-420° in a thermographic investigation of the system. Results, from x-ray diffraction indicate that the lattice is body-centered. There is a subcell with a volume equal to 1/8 the matrix lattice. (FS)

PROPERTIES

REFER ALSO TO CITATION(S) 49548, 49687, 49892, 49893, 50813

50385 (SAND—78-1842C) **Fatigue aging of adhesive bonds.** DeLollis, N.J. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 15p. (CONF-790518—1). P 02/MF A01.

From 10. US/UK symposium on neutron generators; Albuquerque, NM, USA (21 May 1979).

A year long study has been made of the effect of fatigue on the bond between two epoxy encapsulant formulations and a fused alumina disc. The variables studied included isothermal aging at temperatures up to and including the cure temperature and cyclic thermal aging from +74 to -54°C. The encapsulants were glass microballoon filled epoxies differing only in curing agents. One was cured with an aromatic amine eutectic (Shell Curing Agent Z). The other was cured with diethanolamine. The Z cured encapsulant bond failed completely at the bond interface with little or no aging; infrared evidence indicated a soluble interlayer as a possible cause of failure. The diethanolamine cured encapsulant survived a year of isothermal aging with little or no evidence of bond degradation. Cyclic thermal aging resulted in gradual bond failure with time. An extrapolation of the cyclic aging data indicates that the stresses induced by thermal cycling would result in complete bond failure in about 1200 days.

50386 **Velocity interferometer technique to determine shear-wave particle velocity in shock-loaded solids.** Chhabildas, L.C.; Sutherland, H.J.; Asay, J.R. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. 8, 5196-5201(Aug 1979).

An optical technique is described which uses velocity interferometers to determine the large particle velocity changes associated with plane shear-wave propagation. In this technique two velocity interferometers are used to monitor different diffracted laser beams from a surface which undergoes both longitudinal and shear motion. Fringes produced in the interferometer are proportional to a linear combination of both the longitudinal and shear components of the free-surface velocity. The technique has been used successfully to monitor the free-surface velocity of a Y-cut quartz specimen impacted by an X-cut quartz plate. Although the present shear-wave velocity profiles are limited to an accuracy of +- 10%, the accuracy can be easily increased by an order of magnitude by using longer delay legs and larger diffraction angles.

50387 **Kinetics of decomposition of amorphous hydrogenated silicon films.** McMillan, J.A.; Peterson, E.M. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **50**: No. 8, 5238-5241(Aug 1979).

The decomposition kinetics of amorphous hydrogenated silicon films have been studied by thermomanometric analysis at constant heating rate. rf and dc-biased rf glow-discharge films, as well as films deposited by reactive sputtering, have been analyzed and the results used to determine the thermodynamic parameters characterizing the activation barriers for decomposition of the $=SiH_2$ and equivalent SiH centers. Conclusions regarding the structure of these films are presented on the basis of kinetic evidence and parallel infrared absorption studies.

50388 **First- and second-order Raman scattering from finite-size crystals of graphite.** Nemanich, R.J.; Solin, S.A. (Xerox Palo Alto Research Center, Palo Alto, California 94304). *Phys. Rev., B: Condens. Matter;* **20**: No. 2, 392-401(15 Jul 1979).

First- and second-order Raman scattering from graphite has been studied. The second-order spectra of single crystals and of highly oriented pyrolytic graphite are continuous and exhibit several well-defined bands which can be attributed to features in the density of vibrational states as determined from current lattice-dynamics models. The density of states deduced from the lattice-dynamics model of Nicklow, Wakabayashi, and Smith provides the best replication of the second-order Raman spectrum, but is nevertheless somewhat deficient in this regard, and in need of improvement. The dependence of the first- and second-order graphite Raman spectra on crystallite size has also been studied for a series of samples with typical dimensions L/sub c/ and L/sub a/ as small as 30 A. With decreasing crystal size the features in the second-order spectrum broaden noticeably and additional broad features appear in both the first- and second-order spectra. The additional first- and second-

order features are also attributed to structure in the vibrational density of states and arise from the wave-vector selection-rule relaxation that results from finite-crystal-size effects. Evidence is presented to demonstrate that the above described spectral features are intrinsic and not associated with impurity excitations.

50389 Tunneling in hydrogenated amorphous silicon. Balberg, I.; Carlson, D.E. (RCA Laboratories, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **43**: No. 1, 58-61(2 Jul 1979).

For the first time, structure has been found in the electron tunneling characteristics of a metal-oxide-semiconductor tunnel junction of an amorphous semiconductor. In the present study the amorphous semiconductor is phosporus-doped hydrogenated amorphous silicon. The results have been analyzed to determine the surface density of states over part of the forbidden gap. The basic features of the density-of-states distribution are in agreement with the results of field-effect measurements reported for this material.

50390 Reflectance of thinly oxidized silicon at normal incidence. Huen, T. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Appl. Opt.;* **18**: No. 12, 1927-1932(15 Jun 1979).

Calculated values of reflectance at normal incidence for thinly oxidized silicon wafers are presented. The calculations, which use published, experimentally derived optical constants, cover the spectral range from ultraviolet (0.38 μm) to near infrared (1.24 μm). Oxide thickness varied in 0.1-μm steps from 0 to 1 μm, the range of practical interest to technologists in silicon and integrated circuits. Reflectance curves are correlated with the interference color chart for oxidized silicon. Finally, the dependence of reflectance on oxide thickness at three common laser wavelengths is graphed, for those interested in the recently developed endpoint detection techniques of plasma etching.

50391 Theory of superconductivity in ternary rare-earth compounds. II. Machida, K.; Youngner, D. (Ames Laboratory: USDOE and Department of Physics, Iowa State University, Ames, Iowa). *J. Low Temp. Phys.;* **35**: No. 5, 561-568(1 Jun 1979).

In an earlier paper a theory of superconductivity in ternary rare-earth compounds which examined the effects of elastic scattering of conduction electrons by localized 4f electrons was presented. In this paper the theory is extended by treating both elastic and inelastic scattering. Expressions for the phase diagram and the upper critical field are derived and compared with expressions from other theories.

50392 Formal treatment of some low-temperature properties of melting solid helium-3. Goldstein, L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico). *J. Low Temp. Phys.;* **35**: No. 3, 299-312(1 May 1979).

Recent observations of the low-field-strength paramagnetic susceptibility of melting solid ^{3}He indicate its Curie—Weiss-type behavior at temperatures T> or $\simeq$5 mK. These require an identical temperature behavior of the magnetic melting-pressure shift over the same temperature range. Melting-pressure-shift measurements should thus independently confirm the observed temperature behavior of the susceptibility and yield, in addition, the curie constant of melting solid ^{3}He. Using the theoretical value of this constant in the low- or moderate-field-strength melting-pressure-shift formula, the calculated shifts appear to be currently accessible to measurements with acceptable accuracy at T> or $\simeq$5 mK. The inverse problem of determination of the paramagnetic moment or magnetization of melting solid ^{3}He from melting-pressure shifts may be solved on the basis of a differential magnetothermodynamic relation without significant limitations on the applied external magnetic field strength or on the temperature range. Helium-3 melting-pressure and temperature measurements in the presence of a constant and uniform magnetic field of known strength should enable, within the above formalism, the determination of the magnetic phase diagram of solid ^{3}He at melting down to the lowest experimentally accessible temperatures. This approach may supplement other independent methods of magnetic phase-boundary-line determinations of solid ^{3}He.

50393 Superconductivity of ternary rare-earth compounds. Machida, K.; Youngner, D. (Ames Laboratory: USDOE and Department of Physics, Iowa State University, Ames, Iowa). *J. Low Temp. Phys.;* **35**: No. 3, 449-463(1 May 1979).

A theoretical discussion of ternary rare-earth compounds which enter the superconducting state at a temperature T/sub c1/, then ferromagnetically order at T/sub M/<T/sub c1/, is given. The local moments of the rare-earth elements couple to the superconducting electrons so that as T/sub M/ is approached from above, the growth of spin fluctuations suppresses the superconductivity, then completely destroys it at T/sub c2/(>T/sub M/). Expressions for the phase diagram, several thermodynamic quantities, the upper critical field, and the dilution effect are derived.

50394 Stresses in thermal insulations of hot gas ducts caused by temperature gradients and pressure transients. Broeckerhoff, P.; Lang, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). pp 1-10 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Gas cooled reactors require internal thermal insulation. This is attached to the inner surface of the pressure vessels or hot ducts which are in contact with the hot gas. The main object is to protect the walls from inadmissable temperatures. Initially a metallic foil insulation and a fibre insulation have been tested. The first design of the foil insulation did not behave satisfactorily. Circumferential temperature variations of 320 K at a mean gas temperature of 660 K occured due to natural convection in gaps. Thus inadmissible thermal stress resulted in some sealing elements of the insulation. Besides the two types of insulations mentioned above ceramic materials are applied in reactor technology. For instance the hottest region below the core of the Fort St. Vrain reactor is insulated with blocks of Masrock. Furthermore rings of silica, silica nitride or kohlestein are considered for the insulation of hot gas ducts of other reactors. The advantage of this type of insulation is expected to become relevant during mounting. On this background a kohlestein-insulation has been tested in the High Pressure Wind Tunnel under air and helium conditions. The main objectives of the tests were: the efficiency of the insulation and the effect of gaps, fabrication tolerances, porosity and axial pressure gradients on the temperature distribution. These details are of importance to predict the thermal stress of the material.

50395 Tests on model of a prestressed concrete nuclear pressure vessel with multiple cavities. Favre, R.; Koprna, M.; Jaccoud, J.P. (Ecole Polytechnique Federale, Lausanne (Switzerland)). pp 1-13 of Structural mechanics in reactor technology. Vol. H. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The prestressed concrete pressure vessel (prototype) is a cylinder having a diameter of 48 m and a height of 39 m. It has 25 vertical cavities (reactor, heat exchangers, heat recuperators) and 3 horizontal cavities (gas turbines of 500 kw). The cavities are closed by plugs, and their tightness is ensured by a steel lining. A model, on a scale of 1/20, made of microconcrete, was loaded in several cycles, by a uniform inner pressure in the cavities, increasing to the point of failure. The three successive stages were examined: stage of globally elastic behavior; cracking stage; ultimate stage.

RADIATION EFFECTS

50396 Growth of dislocations during laser melting and solidification. Narayan, J.; Young, F.W. Jr. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Appl. Phys. Lett.;* **35**: No. 4, 330-332(15 Aug 1979).

Silicon crystals containing dislocations which terminated in the free surface were melted to depths of about 0.5 μm by rube-laser pulses, and the growth characteristics of dislocations of various types were studied by transmission electron microscopy. It was found that both edge- and screw-type dislocations grew in <113> directions that were not normal to the crystal-growth interface.

CHEMISTRY

50397 SO_2 oxidation by HONO in atmospheric aerosols. Ross, D.S,. (Standord Research Inst., Menlo Park, CA). *Environ. Sci. Technol.;* **12**: No. 6, 726(Jun 1978).

In response to earlier work on nitrate formation in atmospheric aerosols by A.E. Orel and J.H. Seinfeld [Abstract No. 24-32865], it was shown that the oxidation of SO_2 by HONO could play a significant role in the heterogeneous chemistry of the atmosphere. At 25°C in 10% sulfuric acid, HONO oxidized hydrated SO_2 completely at characteristic reaction times of 15 to 30 sec. Both reactants were 0.001 to 0.0001 M. The reaction rate was unaffected by the presence of 0.0001 M nitric acid, which, alone in the same medium, did not oxidize hydrated SO_2, at least at very high rates.

ANALYTICAL AND SEPARATIONS CHEMISTRY

50398 (CONF-790702—1) **Laboratory design for modern analytical instruments.** Wheeler, G.V. (Allied Chemical Corp., Idaho Falls, ID (USA)). 1979. Contract EY-76-C-07-1570. 14p. P 02/MF A01.

From International conference on atomic spectroscopy; Cambridge, UK (1 Jul 1979).

The Idaho National Engineering Laboratory is planning two new buildings which will include analytical chemistry laboratories

housing spectroscopic instruments. The rationale used in designing these laboratories is discussed.

50399 Investigation into the operating characteristics of a "microarc" atmospheric-pressure glow discharge. Bystroff, R.I.; Layman, L.R.; Hieftje, G.M. (Department of Chemistry, Lawrence Livermore Laboratory, Livermore, California 94550). *Appl. Spectrosc.;* **33**: No. 3, 230-240(May 1979).

Details of the processes occurring during sample atomization from a "microarc" discharge have been studied photometrically, by use of high-speed color cinematography and through current-voltage waveforms. The microarc studied here is an atmospheric-pressure inert-gas glow discharge supported between 0.25 mm diameter tungsten wires; quiescent argon-1% H_2 provides reactive-sputtering conditions and improved behavior in the presence of oxygen impurities. Excitation temperatures of ca. 5000 °K are measured for the argon glow. Samples of Na, Al, and Sr illustrate the influence of votatile, refractory, insulating, and electron-emitting sample properties on the temporal-spatial-electrical behavior of the discharge. The step-by-step events occurring in the discharge are described qualitatively and a variety of proceses are invoked to explain sample volatization, including sputtering, chemical reactions, and purely thermal effects. In the first stages of the discharge, instabilities are related to the placement and insulating character of deposits. With heating, electron emission becomes important in directing the discharge to or away from the sample; abnormal glow wandering and glow-to-arc transitions can ensue. Improved stability is achieved by uniformly depositing multi-element samples along the electrode, which localizes the initial discharge and promotes ablative cooling of the sample and electrode.

50400 Methods for chemical analysis of water and wastes. Cincinnati, OH; Environmental Protection Agency (Mar 1979). 521p. (EPA—600/4-79-020). U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, 26 W. St. Clair St., Cincinnati, OH.

This manual provides test procedures approved for the monitoring of water supplies, waste discharges, and ambient waters, under the Safe Drinking Water Act, the National Pollutant Discharge Elimination System, and Ambient Monitoring Requirements of Section 106 and 208 of Public Law 92-500. The test methods have been selected to meet the needs of federal legislation and to provide guidance to laboratories engaged in the protection of human health and the aquatic environment.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 50009, 50543

50401 (Y/DK—225) **Analysis for polychlorinated biphenyls in environmental samples.** Adams, T.T.; Williams, N.J.; McElhaney, R.J.; Viator, R.A. (Oak Ridge Y-12 Plant, TN (USA)). Jun 1979. Contract W-7405-ENG-26. 18p. P 02/MF A01.

Polychlorinated biphenyls (PCB's) have been found to be widely distributed and very persistent in the environment. The various techniques used by the Y-12 Plant Laboratory for the analysis of PCB's are described.

50402 Nylon membrane electrode selective for high molecular weight alkyl aryl sulfonates. Hoke, S.H.; Collins, A.G.; Reynolds, C.A. (Dept. of Energy, Bartlesville, OK). *Anal. Chem.;* **51**: No. 7, 859-862(Jun 1979).

A nylon membrane electrode selective for pentadecyl benzene sulfonate is described. The active material in the membrane is a quaternary ammonium sulfonate salt. The electrode gives Nernstian response to pentadecyl benzene sulfonate from the critical micelle concentration down to 10^{-7} M. Selectivity coefficients for several sulfonates and inorganic anions are given. The electrode has been used as an end-point indicator for the potentiometric titration of sulfonates. The results from this method and the Methylene Blue Method for several petroleum sulfonates compare favorably.

50403 Adsorption of mercury vapor by gold and silver. Mercer, T.T. (Univ. of Rochester School of Medicine and Dentistry, NY). *Anal. Chem.;* **51**: No. 7, 1026-1030(Jun 1979).

The sticking probability is unity for mercury vapor hitting a gold or freshly-formed silver surface. Adsorption isotherms for gold films indicate that it is not significantly affected by film aging, at least over periods as long as 235 h. Adsorption isotherms for silver films deteriorate rapidly with aging, indicating a marked decline in sticking probability. The absorptive capacity of gold films is approximately 0.7 μg Hg per cm^2 of superficial film area. The adsorptive capacity for silver films varies significantly with aging time. Silver wool, silvered Chromsorb P, and silver membrane filters adsorb amounts of mercury equivalent to 2/3—1 1/2 monolayers ($\simeq$ 0.36 $\mu g/cm^2$).

50404 Accurate determination of 5-25 mg of uranium by redox titrimetry. Reeder, S.D.; Delmastro, J.R. (Allied Chem Corp, Idaho Falls, Idaho). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 247-252(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

A precise and selective potentiometric titration method for determining 5-25mg of uranium has been developed. The method is essentially a scaled-down version of the modified Davies-Gray titrimetric method. The method has been automated by interfacing a 10-mL Mettler buret with a pre-programmed HP-9830 calculator. A precision and accuracy of 0.05% or better is obtainable with this method. The method is especially useful for the determination of uranium when the quantity available for analysis is limited. It has been used for verification of the uranium concentration of various standards used in analyses performed at the Idaho Chemical Processing Plant. 7 refs.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 49583, 49584

50405 (EMSL-LV—0539-17) **Radiochemical analytical procedures for analysis of environmental samples.** Johns, F.B.; Hahn, P.B.; Thome, D.J.; Bretthauer, E.W. (eds.). (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Mar 1979. Contract EY-76-A-08-0539. 115p. P 06/MF A01.

This manual is a compilation of the chemical and physical procedures used at the Environmental Monitoring and Support Laboratory—Las Vegas for determining radionuclides in environmental surveillance samples. It supersedes the Handbook of Radiochemical Analytical methods published as EPA-680/4-75-001 in February 1975. It should be noted that the procedures in the current compilation are intended for use in processing relatively large numbers of samples in the shortest possible time for environmental radiological surveillance and, therefore, in some cases represent a compromise between precise analytical determination and adequate determination for surveillance purposes.

50406 Determination of americium in small environmental samples. Knab, D. (Los Alamos Scientific Lab., NM). *Anal. Chem.;* **51**: No. 7, 1095-1097(Jun 1979).

A qualitative method has been developed for the detection of trace amounts of americium in less than two grams of prepared environmental samples. The procedure is moderately short and utilizes two ion-exchange columns and electrodeposition. The techniques for sample dissolution are described. Americium is determined by alpha spectroscopy.

50407 Preparation of uranium standard solutions for x-ray fluorescence analysis. Wong, C.M.; Cate, J.L.; Pickles, W.L. (Univ of Calif, Lawrence Livermore Lab). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 149-155(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

The purpose of this study was to develop a method of preparing uranium standards for x-ray fluorescence analysis to meet the requirement of the Safeguard Programs at Lawrence Livermore Laboratory. Some of these requirements were that the standards source material must be of high purity; the method of preparation of the standard solution must be accurate; the aliquoting technique must be precise; the standard configuration must be suitable for x-ray fluorescence measurement; and, the maximum error associated with all aspects of preparation must be minimal and well known. 3 refs.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 49457, 49471

50408 (CONF-790658—2) **Analysis of U and Pu resin bead samples with a single stage mass spectrometer.** Smith, D.H.; Walker, R.L.; Bertram, L.K.; Carter, J.A. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 2p. P 02/MF A01.

From 27. annual conference on mass spectrometry and allied topics; Seattle, WA, USA (3 Jun 1979).

Resin bead sampling enables the shipment of nanogram U and Pu quantities for analysis. Application of this sampling technique to safeguards was investigated with a single-stage mass spectrometer. Standards gave results in good agreement with NBS certified values. External precisions of +-0.5% were obtained on isotopic ratios of ~ 0.01; precisions on quantitative measurements are +-1.0%. (DLC)

50409 (LA-UR—79-1474) **Broadly tunable picosecond ir source.** Campillo, A.J.; Hyer, R.C.; Shapiro, S.L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 18p. (CONF-790529—4). P 02/MF A01.

From Conference on Optics; Los Alamos, NM, USA (23 May 1979).

A completely grating tuned (1.9 to 2.4 μm) picosecond traveling wave IR generator capable of controlled spectral bandwidth operation down to the Fourier Transform limit is reported. Subsequent down conversion in CdSe extends tuning to 10 to 20 μm.

50410 Helmholtz resonance cells for pulsed dye laser-excited high resolution optoacoustic spectroscopy. Shaw, R.W. (Analytical Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Appl. Phys. Lett.;* **35**: No. 3, 253-255(1 Aug 1979).

The signal waveform observed in optoacoustic measurements is complex and highly dependent on sample for open-cavity cells and pulsed optical excitation. A Helmholtz resonator (HR) cell has been employed to reduce this dependence on sample and thus simplify signal processing. The cell background signal is likewise reduced with the HR cell. An optoacoustic (OA) spectrum of holmium oxide powder is presented to demonstrate the utility of this cell with pulsed dye laser excitation for acquistion of high resolution OA spectra of solids.

50411 Intracavity absorption with external fluorescence measurement for detection of radioiodine isotopes. Hohimer, J.P.; Hargis, P.J. Jr. (Sandia Labs., Albuquerque, NM). *Anal. Chem.;* **51**: No. 7, 930-932(Jun 1979).

We report the use of intracavity absorption in a CW dye laser as a sensitive analytical method for the detection of iodine-129. With an external fluorescence detection scheme employing photon counting, quantitative isotope specific measurements of $^{127}I_2$ and $^{129}I_2$ have been made at concentrations in the range of 5×10^{11} to 7×10^{15} molecules/cm^3. Scaling estimates indicate that a lower level may be achieved if desirable. In addition, this method permits the simultaneous detection of a number of iodine isotopes.

50412 Trace metal analysis of petroleum, petroleum products, and alternative fuels by atomic fluorescence/emission spectrometry. Brinkman, D.W.; Whisman, M.L.; Goetzinger, J.W. (U.S. Department of Energy, Bartlesville Energy Technology Center, P.O. Gox 1398, Bartlesville, Oklahoma 74003). *Appl. Spectrosc.;* **33**: No. 3, 245-248(May 1979).

While atomic fluorescence is attractive as a sensitive multielement technique, lack of a commercial instrument and the need for a dedicated computer system have discouraged its use. A system is described which incorporates atomic emission and fluorescence while using only commercially available instrumentation. A programable calculator operates the system and performs all data manipulation and reduction. The result is an instrument capable of doing routine multi-element analyses without the need for a highly trained operator.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 50785

50413 (CONF-790415—36) **Extraction of DBP and MBP from actinides: application to the recovery of actinides from TBP—Na_2CO_3 scrub solutions.** Horwitz, E.P.; Mason, G.W.; Bloomquist, C.A.A.; Leonard, R.A.; Bernstein, G.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 41p. P 03/MF A01.

From 177. ACS national meeting; Honolulu, HI, USA (1 Apr 1979).

A flowsheet for the recovery of actinides from TBP—Na_2CO_3 scrub waste solutions has been developed, based on batch extraction data, and tested, using laboratory scale counter-current extraction techniques. The process utilizes 2-ethyl-1-hexanol (2-EHOH) to extract the TBP degradation products (HDBP and H_2MBP) from acidified Na_2CO_3 scrub waste leaving the actinides in the aqueous phase. Dibutyl and monobutyl phosphoric acids are attached to the 2-EHOH molecules through hydrogen bonds. These hydrogen bonds also diminish the ability of the HDBP and H_2MBP to complex actinides and thus all actinides remain in the aqueous raffinate. Dilute sodium hydroxide solutions can be used to back-extract the dibutyl and monobutyl phosphoric acid esters as their sodium salts. The 2-EHOH can then be recycled. After extraction of the acidified carbonate waste with 2-EHOH, the actinides may be readily extracted from the raffinate with DHDECMP or, in the case of tetra- and hexavalent actinides, with TBP. The alcohol extraction (ARALEX) process is relatively simple and involves inexpensive and readily available chemicals. The ARALEX process can also be applied to other actinide waste streams which contain appreciable concentrations of polar organic compounds that interfere with conventional actinide ion exchange and liquid—liquid extraction procedures.

50414 GPA (Gas Processors Association) H_2S removal panel. 2. GPA panelists continue probe into H_2S removal, sulfur recovery. *Oil Gas J.;* **76**: No. 30, 46-49(24 Jul 1978).

A discussion by R.L. Pearce (Dow Chem. Co) at the 57th GPA Annual Conventional (New Orleans 1978) covers hydrogen sulfide removal with methyl diethanolamine (MDEA), including the development, description, and chemistry of the process; the removal efficiency of MDEA; the selectivity of MDEA for hydrogen sulfide removal from gases containing both hydrogen sulfide and carbon dioxide, including a comparison with the selectivities of monoethanolamine (MEA) and diethanolamine (DEA); the MDEA regeneration procedure; the low energy requirement for MDEA gas removal, as compared with other amines; the minor corrosion (about 26 mils/y) experienced at high (~ 50 wt%) MDEA concentrations; and a comparison of the physical properties of MDEA, MEA, and DEA. Flow diagram, graphs, and tables are included.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 50341

50415 (BNL—26129) **Crystal structure of $PrOHSO_4$.** Fahey, J.A.; Williams, G.J.B.; Haschke, J.M. (Bronx Community Coll., New York (USA). Dept. of Chemistry; Brookhaven National Lab., Upton, NY (USA); Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1979. Contract EY-76-C-02-0016. 12p. (CONF-790641—6). P 02/MF A01.

From Rare earth research conference; Fargo, ND, USA (25 Jun 1979).

$PrOHSO_4$ was prepared by hydrothermal reaction of $Pr(OH)_3$ with $Pr_2(SO_4)_3 \times H_2O$ at 450 to 500°C and 1,200 +- 200 atm water pressure. The space group is $P2_1/c$; the cell parameters are a = 4.488, b = 12.495, c = 7.091 A, β = 111.08, Z = 4, d/sub x/ = 4.49 g/cm^3. Atomic coordinates and anisotropic thermal parameters are tabulated. A stereoscopic protection of the cation coordination sphere is shown and discussed. 2 figures, 3 tables. (DLC)

50416 (COO—4948-1) **Energies and bonding in manganese phosphides. Annual progress report, July 1, 1978—June 30, 1979.** Myers, C.E.; Jung, E.D. (State Univ. of New York, Binghamton (USA). Dept. of Chemistry). Mar 1979. Contract ER-78-S-02-4948. 12p. P 02/MF A01.

Manganese monophosphide and other first row transition metal phosphides have been studied by x-ray photoelectron spectroscopy. Electron bindng energies of both valence-conduction band and core level electrons show an evolution of metallic behavior in the series ScP, TiP, VP, MnP, FeP. Phosphorus dissociation pressure measurements on MnP lead to: 4MnP/sub (s)/ = $2Mn_2P$/sub (s)/ + P/sub 2(g)/ , $\Delta H^0_{298\ 15}$ = 69.8 kcal when the data are treated by the third law method using estimated entropies. Combination of this result with published data yields ΔH^0/sub f,298.15/(MnP) = -27.2 kcal/mole which is in satisfactory agreement with the published value of -23.0 kcal/mole. The apparently low value of the atomization enthalpy of MnP is confirmed and is attributed to a high valence state preparation energy.

50417 (NUREG/CR—0745) **Measured and predicted gas flow rates through rough capillaries.** Owzarski, P.C.; Sutter, S.L.; Mishima, J.; Schwendiman, L.C.; Bander, T.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1979. 89p. C .

To help predict the flow or airborne particles through microscopic leaks in plutonium dioxide shipping containers during postulated accidents, a comparative study of experimental and calculated gas flow rates through rough metal microcapillaries was carried out. A computer model, Code CAPIL, was developed to predict gas flows. The following conclusions were made from the comparison of CAPIL predicted flows and experimental flows: experimental flows were in the continuum fluid flow regime; laminar flow could be stable to Reynolds numbers up to 5000; turbulent friction factors were lower than expected as a result of longitudinal groove roughness of the capillaries or thicker than expected laminar boundary layers; CAPIL flows were usually within 85 to 105% of the measured flows; attenuation of standard flow as the temperature was raised was caused by higher viscosity and lower fluid density at elevated temperatures; and entrance and exit losses were a significant part of the total flow resistance.

50418 Effect of inlet mole ratio of NO_2/NO and the contribution of oxygen in the catalytic reduction of nitrogen oxides with ammonia. Kasaoka, S.; Sasaoka, E. (Okayama Univ., Japan). *Nippon Kagaku Kaishi;* **6**: 874-881(Jun 1978). (In Japanese).

The reduction of 500 ppM nitric oxide/nitrogen dioxide mixtures (0 to 100% nitric oxide) with 667 ppM ammonia in the presence of 0 to 5% oxygen and 10% water in nitrogen at 200 to 450°C was tested on unsupported and titanium dioxide- and alumina-supported vanadium pentoxide, ferric sulfate/ferric oxide, ferric sulfate on titanium dioxide, copper(II) exchanged zeolite Y, and cupric sulfate on titanium dioxide or alumina. The results were similar on all catalysts and showed that the conversion of nitrogen oxides to nitrogen has a maximum of 1:1 mole ratio of nitric oxide to nitrogen dioxide; that in the presence of oxygen, the oxidation of

nitric oxide to nitrogen dioxide was large compared with the reduction by ammonia; and that nitrogen dioxide is reduced via nitric oxide to nitrogen by ammonia. The stoichiometry of the reactions was derived. 13 references.

ORGANIC CHEMISTRY

50419 Course lecture (CE-3136): introduction to polymer science (14 May 1979) (Engineering Materials). (California Univ., Livermore (USA). Lawrence Livermore Lab.). (CAPE—2628).

179 drawings.

This introductory course in polymers is designed to give the non-polymer chemist and engineer a working knowledge of both polymer chemistry and the properties of polymeric materials.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 49452

50420 (CONF-790582—1) **Nuclear magnetic resonance studies of nucleoside conformational properties.** Danyluk, S.S. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 23p. P 02/MF A01.

From NATO advanced study institute; Sogesta, Urbino, Italy (7 May 1979).

This paper focuses on the applications of NMR spectroscopy in the conformational analysis of nucleosides and nucleotides. 64 references, 9 figures, 5 tables. (DLC)

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 50265

PHOTOCHEMISTRY

50421 Luminescence quenching of the Bis(2,2'-bipyridine)aquo-2,2'-bipyridineiridium(III) ion and its conjugate base. Bergeron, S.F; Watts, R.J. (Univ. of California, Santa Barbara). *J. Am. Chem. Soc.;* **101**: No. 12, 3151-3156(6 Jun 1979).

Quenching of $Ir(bpy)_2(H_2O)(bpy)^{3+}$ and $IR(bpy)_2(OH)(bpy)^{2+}$ by a variety of charged metal complexes and neutral biacetyl has been studied. Stern—Volmer and quenching constants have been determined and diffusional rate constants for each donor—acceptor combination have been estimated. Quenching efficiencies are comparable to those of $Ru(bpy)_3^{2+}$ with similar quenchers. Quenching is believed to occur by both energy-transfer and electron-transfer mechanisms. The reduction potential of the luminescent state of $Ir(bpy)_2(OH))bpy)^{2+}$ is estimated to be +1.84 V.

RADIATION CHEMISTRY

50422 (CONF-790524—6) **Solvation of the electron in alcohols studied using the Argonne picosecond pulse radiolysis stem.** Johah, C.D.; Kenney-Wallace, G.A. (Argonne National Lab., IL (USA); Toronto Univ., Ontario (Canada). Dept. of Chemistry). 1979. Contract W-31-109-ENG-38. 9p. P 02/MF A01.

From 6. international congress symposium on radiation research and stem cells; Tokyo, Japan (13 May 1979).

The Argonne picosecond pulse radiolysis system and its application towards understanding solvation processes in polar liquids are described. The alcohols studied are n-butanol, 2-decanol, and t-butanol. (LK)

50423 ESR evidence for a biradical dimer initiator in diacetylene polymerization. Hori, Y.; Kispert, L.D. (Univ. of Alabama, Tuscaloosa). *J. Am. Chem. Soc.;* **101**: No. 12, 3173-3177(6 Jun 1979).

Single-crystal monomers of 5,7-dodecadiyne-1,12-diol bis(phenylurethane0 X-ray irradiated at 77 K give rise to an ESR spectrum at 77 K consisting primarily of lines due to radical pairs along with some weaker lines due to S = 1/2 radicals. The radical pair is a biradical of a diacetylene dimer with D = 732 G and E = 26.5 G and appears to be the initiator of solid-state polymerization of X-ray irradiated TCDU crystals at low conversion.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

50424 (BNL—26293) **Positron-emitting raionuclides: present and future status.** Lambrecht, R.M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 14p. (CONF-790321—8). P 02/MF A01.

From 2. international symposium on radiopharmaceuticals; Seattle, WA, USA (18 Mar 1979).

A tabulation of 157 positron-emitting radionuclides that have the physical characteristics deemed appropriate for radiopharmaceutical use in conjunction with positron emission tomography is provided. The most promising radionuclides are within the production capabilities of a variable-energy cyclotron accelerating protons to about 40 MeV and deuterons, helium-3, and helium-4 to compatable energies. To data only 27 positron-emitting radionuclides have been subjected to radiopharmaceutical consideration, whereas only ^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{38}K, and ^{68}Ga have proved to be especially promising. 2 tables.

50425 (LBL—7701, pp 51-55) **Chemical properties of einsteinium: part 1.** Hulet, E.K. (Lawrence Livermore Lab., CA). Apr 1979.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

The ionic and solution chemistry of einsteinium is discussed. Graphs show stability constants, amalgamation rates, and amalgamation potential. (LK)

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 49594, 49595, 49596, 49597

50426 (ORO—5773-T1) **Characteristic parameters in combustion processes and their accessibility to current and future diagnostics. Progress report, March 1, 1978—May 31, 1979.** Goulard, R. (George Washington Univ., Washington, DC (USA). School of Engineering and Applied Science). 31 May 1979. Contract ER-78-S-05-5773. 43p. P 03/MF A01.

It is proposed to pursue the current evaluation of combustion diagnostics with a view to identify which diagnostics techniques are best suited to each particular set of experiments. It is important not only to establish the parameters to be measured in each case, but also their quantitative range; only thus can be achieved the selection of an appropriate measurement device or, if none is available, can the need for further instrumentation development be established. The criteria used for this evaluation are most affected by several areas in rapid development in the instrumental field (e.g. sensor noise limitation and real time data processing) and also by the new technological demands for scientific information (e.g. turbulence structure and particulate formation or destruction). Some of these aspects are reviewed in this proposal and it is expected that a complete review and set of evaluation criteria will be available at the end of this proposed second year of effort.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 49973, 49989, 49990, 49993, 50815

50427 (CONF-790435—2) **Statistical techniques for automating the detection of anomalous performance in rotating machinery.** Piety, K.R.; Magette, T.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 24p. P 02/MF A01.

From CAM-I international spring seminar; New Orleans, LA, USA (9 Apr 1979).

The level of technology utilized in automated systems that monitor industrial rotating equipment and the potential of alternative surveillance methods are assessed. It is concluded that changes in surveillance methodology would upgrade ongoing programs and yet still be practical for implementation. An improved anomaly recognition methodology is formulated and implemented on a minicomputer system. The effectiveness of the monitoring system was evaluated in laboratory tests on a small rotor assembly, using vibrational signals from both displacement probes and accelerometers. Time and frequency domain descriptors are selected to compose an overall signature that characterizes the monitored equipment. Limits for normal

operation of the rotor assembly are established automatically during an initial learning period. Thereafter, anomaly detection is accomplished by applying an approximate statistical test to each signature descriptor. As demonstrated over months of testing, this monitoring system is capable of detecting anomalous conditions while exhibiting a false alarm rate below 0.5%.

50428 (HEDL-SA—1733-FP) **Recent advances in magnetic liquid sealing.** Raj, K.; Stahl, P.; Bottenberg, W.; True, D.; Martis, G.; Zook, C. (Hanford Engineering Development Lab., Richland, WA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA); Ferrofluidics Corp., Burlington, MA (USA)). Jan 1979. Contract EY-76-C-14-2170. 35p. (CONF-790593—1). P 03/MF A01.

From 26. annual design engineering show and conference; Chicago, IL, USA (7 May 1979).

In this paper recent work in design and testing of two special magnetic liquid seals extending the state-of-the-art of ferrofluidic sealing is discussed. These custom seals are a moving belt edge seal and an exclusion seal. The first seal provides a hermetic barrier to solid particulates expected to be present in enclosed nuclear environments. The second seal is used on a magnetic disk drive spindle and reduces the particulate contaminants in the memory disk pack area by up to three orders of magnitude. In addition, bearing life in the spindle is found to be doubled due to reduction of operating temperature. The fundamentals of magnetic fluid sealing are presented in terms of magnetic circuit design and physical properties of ferrofluids.

50429 (SAND—79-1365C) **Analysis of reentry vehicle trajectory reconstruction and parameter identification.** McDowell, J.L.; Schutz, B.E.; Tapley, B.D. (Texas Univ., Austin (USA); Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 11p. (CONF-790826—2). P 02/MF A01.

From Atmospheric flight mechanics conference; Boulder, CO, USA (6 Aug 1979).

An analysis has been made of a method for postflight reconstruction of reentry vehicle states and the identification of associated model parameters using the Trajectory Analysis Program (TRAP). The present investigation focuses on the extent to which a reduced order dynamical model can be utilized to reconstruct reentry vehicle trajectories and to estimate aerodynamic coefficients from onboard observations of the vehicle motion. The feature of local arc trajectory partitioning is disucssed and its application to the reentry vehicle problem is described. Numerical results derived from simulated measurements are presented which illustrate the feasibility of this approach.

50430 **Tool calibration for micromachining system.** Miller, D.M. (to Department of Energy). US Patent 4,142,296. 6 Mar 1979. Filed date 14 Dec 1977. 26p.

PAT-APPL-860,653.

The invention discloses a tool calibration system including a tool calibration fixture and a tool height and offset calibration insert for calibrating the position of a tool bit in a micromachining tool system. The tool calibration fixture comprises a yokelike structure having a triangular head, a cavity in the triangular head, and a port which communicates a side of the triangular head with the cavity. Yoke arms integral with the triangular head extend along each side of a tool bar and a tool head of the micromachining tool system. The yoke arms are secured to the tool bar to place the cavity around and a tool bit which may be mounted to the end of the tool head. Three linear variable differential transformer's (LVDT) are adjustably mounted in the triangular head along an X axis, a Y axis, and a Z axis. The calibration insert comprises a main base which can be mounted in the tool head of the micromachining tool system in place of a tool holder and a reference projection extending from a front surface of the main base. Reference surfaces of the calibration insert and a reference surface on a tool bar standard length are used to set the three LVDT's of the calibration fixture to the tool reference position. These positions are transferred permanently to a mastering station. The tool calibration fixture is then used to transfer the tool reference position of the mastering station to the tool bit.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 50894

50431 (LA—7781-PR) **Magnetic refrigerator development. Progress report, December 1, 1978—February 28, 1979.** Barclay, J.A.; Steyert, W.A.; Zrudsky, D.R. (Los Alamos Scientific Lab., NM (USA)). Aug 1979. Contract W-7405-ENG-36. 12p. P 02/MF A01.

The objectives of this program are to develop new, low-cost, high-efficiency, magnetic refrigeration methods for cooling large superconducting devices of interest to the electric power industry. During this quarter, testing of the refrigerator was begun. Initial tests with no magnetic field are reported, as are tests taken with a modest applied field. In these preliminary tests, the unit pumped heat over a 9°C span, and over a 7°C span, it pumped 0.5 kW. The unit was also successfully operated as a heat engine.

50432 **Fabrication of superconducting Nb_3Sn-Cu composites.** Verhoeven, J.D.; Gibson, E.D.; Owen, C.V.; Ostenson, J.E.; Finnemore, D.K. (Ames Laboratory—USDOE and Department of Metallurgy, Iowa State University, Ames, Iowa 50011). *Appl. Phys. Lett.;* **35**: No. 3, 270-272(1 Aug 1979).

A new process has been developed for the fabrication of multifilamentary composites of Nb_3Sn in a Cu matrix. Dendritic Cu-Nb alloys are cast as 2.5-kg billets and extruded to a tube shape. The core of the tube is filled with a Sn—5 wt% Cu alloy, and the assembly is drawn to 0.015-cm-diam wire with no intermediate anneals. Reaction of the wire at 550 °C for two days gives a product suitable for magnets in the 8—14-T range.

50433 **Coupling losses in various outer normal layers surrounding the filament bundle of a superconducting composite.** Turck, B. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **50**: No. 8, 5397-5401(Aug 1979).

In multifilamentary composites submitted to a changing external field, coupling currents between the filaments give rise to the so-called coupling losses. These losses can be reduced by using a three-component matrix in the filament bundle itself. However, in the outer normal-conducting layer surrounding the bundle of filaments, significant extra losses from azimuthal coupling currents exist if the thickness of the layer is not small. One can expect a reduction of these losses by introducing a cupronickel shell. The losses are calculated in the three particular cases involving one, two, and three concentric layers of different resistivity.

50434 **Critical currents of SNS junctions with Cu:Mn and Cu:Ni barriers.** Paterson, J.L. (Physics Department, University of Virginia, Charlottesville, Virginia). *J. Low Temp. Phys.;* **35**: No. 3, 371-396(1 May 1979).

Critical supercurrent densities j/sub c/ have been measured for Pb—$Cu_{91}Ni_9$—Pb and Pb—Cu/sub 99.8/Mn/sub 0.2/—Pb junctions over the temperature range $1.3<T<4.2$ K. Diffraction patterns for the junctions indicate highly uniform current densities in the non-self-field- limited regime. The data for the Cu:Ni barriers provide some indication of a spin-flip depairing temperature $\alpha=h/2\pi k$/sub B/π/sub s/$\approx$3 K and the data for Cu:Mn provide some indication of an $\alpha=15$ K; the measured supercurrent densities, however, are only approximately represented by the derived expression J/sub c/(T) $=B\exp\{-\gamma[(T+\alpha)/T$/sub c/]/sup 1/2/$\}$. The data for Cu:Mn fit the empirically determined $Jc(T)=Jc(O)\exp[-\beta(T/T$/sub c/)/sup 3/2/] much better; there is, however, no apparent theoretical basis for this expression. The measured junction resistances are 50% higher than the values implied by the measured resistivity of the barrier material for both the Cu:Ni and the Cu:Nn; this excess resistance is presumably contributed by the two S—N interfaces.

PROTECTIVE STRUCTURES AND EQUIPMENT

50435 (SAND—79-0120C) **Electrode slotting process for thin PLZT wafers.** Harris, J.O. Jr.; Luft, V. (Sandia Labs., Albuquerque, NM (USA); Honeywell, Inc., Minneapolis, MN (USA)). 1979. Contract EY-76-C-04-0789. 4p. (CONF-790670—4). P 02/MF A01.

From IEEE international symposium on application of ferroelectric; Minneapolis, MN, USA (13 Jun 1979).

A new electroding technique entitled the electrode slotting process (ESP) has been developed for electroding 0.38-mm thick PLZT wafers for bonded lens assemblies in the USAF EEU-2/P Thermal/Flash Protective Goggle. The electrodes are formed by first cutting a mirror-image pattern of shallow interdigital slots on both sides of the PLZT wafer followed by an electroless plating of these slots and the wafer edge. Experimental results of operating voltage and closed-state optical density with respect to variations in slot depth and electrode geometry are also discussed.

HANDLING EQUIPMENT AND PROCEDURES

50436 (NUREG/CR—0642) **Reference critical experiments. Progress report October 1, 1978—December 31, 1978.** Goebel, G.R.; Pecora, D.; Oh, I.; Pothe, R.E. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). Mar 1979. Contract EY-76-C-04-3533. 58p. (RFP—2888). P 04/MF A01.

This is the thirteenth (13th) in the series of quarterly progress reports describing reference critical experiments being performed at the Critical Mass Facility at Rockwell International's Rocky Flats Plant for the U.S. Nuclear Regulatory Commission (NRC). In addition to a discussion of experiments already performed, a list of criticality experiments needed to provide criticality data for the design and licensing of new facilities is included. Experimental programs currently underway at Babcock and Wilcox, Battelle Pacific Northwest Laboratories, and Rocky Flats are described. Two critical experiments were repeated using the low-enriched, damp ($H/U \sim 0.75$) uranium oxide (U_3O_8) in the plastic reflector. They were repeated to determine the combined effect of parameters (oxide

weight gain, cuboid dimensions, etc.) that might vary. Repeat experimental results are in good agreement with the original experimental results. Two new critical experiments were performed with plastic interspersed between cans of uranium oxide in the concrete reflector. Reweighing of the oxide cans indicates that the oxide continues to gain weight. Composition of the uranium oxide and metals used in the experiments were determined by laboratory analyses.

50437 (NUREG/CR—0827) **Reference critical experiments. Progress report, January—March 1979.** Goebel, G.R.; Oh, I.; Rothe, R.E. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Jun 1979. Contract EY-76-C-04-3533. 49p. (RFP—2932). P 03/MF A01.

Eight critical experiments were performed using the low-enriched, damp (H/U ~ .77) uranium oxide (U_3O_8) in the concrete reflector. This concludes the interstitially-moderated experiments. Two critical experiments were repeated. One was repeated ten months after the original experiment to determine the combined effect of oxide weight gain and statistical error of measurements. The second repeat experiment was performed a few hours after the original experiment, so oxide weight gain would not be a facotor, to see the effect on critical results of restacking and rearranging the oxide cans. Impurity content and particle size distribution of the oxide were determined by laboratory analysis. Water has been added t the uranium oxide to increase the H/U atomic ratio from 0.77 to 1.25. The uranium oxide with an H/U ratio of 1.25 will be used in the next series of experiments. Reweighing of the oxide cans indicates that the oxide continues to gain weight.

SHIPPING CONTAINERS

50438 (INIS-mf—4492, pp v) **Inelastic response of metallic impact limiters.** 1977.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Energy mitigators on some light water reactor (LWR) spent fuel shipping casks and conceptual designs for liquid metal fast breeder reactor (LMFBR) spent fuel shipping casks rely on the inelastic behavior of metallic plate-like structures. A program was undertaken to investigate the response of mitigators to hypothetical shipping accidents with parallel experimental and theoretical studies. The theoretical studies consist of performing large deformation three dimensional transient dynamic analysis on several metal fin designs and correlating the results with the experimental results. The newly developed computer program WULFF was used. WULFF is capable of predicting the dynamic response of solids with elastic-plastic material properties. The finite element displacement formulation with the eight isoparametric elements is used with the innovation of calculating stress components at the nodes of the model. Testing of scale model fin specimens was performed at SLA's drop table facility. The test specimens are mounted on a force transducer and this assembly is bolted to the stationary bottom table. Extra weights are added to the drop table so that the total energy at impact is sufficient to cause large plastic deformation in the specimens. Accelerometers mounted on the drop table and the data from the force transducer are used to compute the energy absorbed during the test. Also framing camera coverage was used to observe the specimen deformation as it develops.

50439 (NUREG/CR—0766) **Dynamic analysis to establish normal shock and vibration of radioactive material shipping packages. Quarterly progress report, October 1, 1978—December 31, 1978.** Fields, S.R.; Mech, S.J. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1979. Contract EY-76-C-14-2170. 60p. (HEDL-TME—79-3). P 04/MF A01.

The basic radioactive material shipping cask-rail car dynamic simulator model, CARDS, has been modified to incorporate the following: draft gear submodels were installed for the couplers between cars, suspension subsystem submodels were installed at the front and rear trucks of the cask-rail car, a term defining the vertical friction force at the coupler face was added to the equations of motion for the cask-rail car, and the model was expanded to include equations of motion for each car in an anvil train. A simulation run was made to test the involved version of CARDS. Propagation of how the shock of impact through the train is shown as plots of coupler force between cars, horizontal displacement of each car in the train, and vertical displacements of points on the cask-rail car, as functions of time after impact. A subroutine was developed for the CARDS model to convert the displacement, velocity and acceleration response of a cask-rail car system from the time domain to the frequency domain. Some of the data recorded during the rail car impact tests conducted at the Savannah River Laboratories from July 14, 1978 through August 3, 1978 have been reduced and analyzed. The reduced data were from Test 1 and were limited to the outputs from Instruments 4, 8 through 12, and 22. Test 1 was an 8.3-mph impact of a 70-ton Seaboard Coastline (SCL) rail car with a standard coupler, carrying a 40-ton Hallam cask held in place by bolted tiedowns with stops. Results of the reduction of these limited data are presented as plots of horizontal and vertical acceeleration as functions of time, horizontal displacement as a function of time, horizontal and vertical accelerations as functions of frequency, and transfer function magnitudes as functions of frequency.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 49462

LASERS

REFER ALSO TO CITATION(S) 50659

50440 (LA—7850-T) **Nonlinear optics: parametric amplification at 16 micrometers and oscillator mode competition.** Wenzel, R.G. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 111p. P 06/MF A01.

Thesis.

Parametric amplification in the 16-μm region in Brewster-cut CdSe is reported. An HF pump laser with a flat radial intensity profile was used, thereby eliminating the need for confocal focusing of pump and signal beams. Plane-wave analysis is therefore used. The gain bandwidth was determined and found to be in agreement with theory. The second-order nonlinear susceptibility was measured for the first time at 16 μm through Miller's Δ. The frequency distributions for a parametric oscillator fitted with sapphire and ZnSe etalons have been measured and interpreted in terms of the probability of oscillation for specific cavity modes. A theoretical model is developed to calculate these probabilities. It involves finding local approximate analytical solutions of the coupled mode amplitude equations of A. Yariv and W.H. Louisell in Theory of the Optical Parametric Oscillator, IEEE JQE, QE-2, 418 (1966). The solutions are then interpreted statistically. Predictions of the model are compared with the measurements. Reasonable agreement is found.

50441 **Seebeck effect position sensor for CO_2 laser beam alignment.** Hammond, R.B.; Gruhn, C.R. (Electronics Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **35**: No. 5, 423-426(1 Sep 1979).

A new concept for a laser position sensor is presented. The device utilizes the Seebeck effect in semiconductors. Results using a Si detector show position linearity and energy linearity of the device signal. A theoretical model explaining the operation of the device is outlined. Applications to pulsed laser beam alignment are discussed.

50442 **Heating-effect minimization in dye lasers.** Matheson, K.L.; Thorne, J.M. (Chemistry Department, Brigham Young University, Provo, Utah 84602). *Appl. Phys. Lett.;* **35**: No. 4, 314-317(15 Aug 1979).

Optical pumping of dye lasers deposits heat nonuniformly in the active medium. Because the refractive index of a liquid or gas is a function of temperature, gradients are created which refract the laser beam. This effect is sometimes serious enough to quench laser action. In this paper, we evaluate the effects caused by optical pumping with a coaxial flashlamp and suggest ultraviolet absorbers and wavelength shifters as materials for minimizing the problem.

50443 **High-energy optically pumped molecular lasers in the 13- and 16-μm regions.** Tiee, J.J.; Fischer, T.A.; Wittig, C. (Electrical Engineering department, University of Southern California, University Park, Los Angeles, California 90007). *Rev. Sci. Instrum.;* **50**: No. 8, 958-961(Aug 1979).

This paper describes the construction of an optically pumped laser device. The device utilizes a line-tunable CO_2 TEA laser as a source to optically pump a cell which is capable of cooling candidate laser gases down to ~150 °K. Laser outputs of 750 mJ in the 13-μm region and 100 mJ in the 16-μm region are obtained by pumping NH_3 and CF_4 respectively with 10 J of CO_2 laser radiation. The measured conversion efficiencies are 15% for NH_3 and 3% for CF_4. These lasers can be used to photodissociate polyatomic molecules and are attractive sources for practical laser isotope separation.

50444 **Closure phenomena in pinholes irradiated by Nd laser pulses.** Auerbach, J.M.; Holmes, N.C.; Hunt, J.T.; Linford, G.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Appl. Opt.:* **18**: No. 14, 2495-2499(15 Jul 1979).

An experimental investigation has been made on plasma closure in pinholes irradiated by Nd glass laser pulses; 300—500-μm diam pinholes of various materials and thicknesses have been irradiated by 20—100-J 300-psec FWHM pulses on the Janus laser system. Calorimetry measurements have yielded data on pinhole energy transmission and intensity loading on the periphery of the pinhole. Ultrafast streak photography measurements indicate effective clo-

sure velocities of 2—5 x 10^7 cm/sec. Scattered light measurements have shown the transmission loss through a typical spatial filter configuration to be primarily refractive in nature.

50445 High-efficiency free-electron laser. Lin, A.T.; Dawson, J.M. (Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* **42**: No. 25, 1670-1673(18 Jun 1979).

The electronic conversion efficiency of a free-electron laser using an intense relativistic electron beam in a rippled magnetic field as its active medium is limited mainly by the destruction of the coherent slow space-charge wave through particle trapping and the depletion of the available beam energy. It is shown that by proper stepping up of the ripple magnetic field strength prior to electrostatic wave saturation, the efficiency can be substantially increased along with some bandwidth improvement and shortening of the device length.

50446 Computer controlled cw laser spectrometer. Pollock, C.R.; Kasper, J.; Ernst, G.K.; Ernst, W.E.; Blit, S.; Tittel, F.K. (Rice University, Department of Electrical Engineering, Houston, Texas 77001). *Appl. Opt.;* **18**: No. 12, 1907-1912(15 Jun 1979).

A computer controlled cw UV—visible dye laser source for spectroscopic use has been developed. Computer control facilitates both continuous single-frequency scanning and data acquisition. With 4 W of Ar-ion laser pump power, such a spectrometer can generate in excess of 1 W of cw single-frequency power in the visible and up to 1 mW in the UV by using extracavity nonlinear optical mixing. The laser spectrometer has been tested by performing high-resolution measurements of the fluorescence spectrum of I_2 in the visible and of the absorption spectrum of SO_2 in the UV.

50447 Transverse-mode stabilized Ga/sub 1-x/Al/sub x/As visible diode lasers. Kajimura, T.; Kuroda, T.; Yamashita, S.; Nakamura, M.; Umeda, J. (Hitachi, Ltd., Central Research Laboratory, Kokubinji, Tokyo, 185 Japan). *Appl. Opt.;* **18**: No. 11, 1812-1815(1 Jun 1979).

Transverse-mode stabilized visible diode lasers in the 0.7-μm wavelength region are fabricated by growing a Ga/sub -1x/Al/sub x/As double heterostructure on a grooved GaAs substrate (channedled-substrate-planar structure). The diodes operate stably in the fundamental transverse mode and provide nonstigmatic laser beams. They can be collimated with a 0.5—1-mrad beam divergence using a simple graded-index fiber lens. Corresponding to single-longitudinal-mode operation at current levels above 1.1 times the theshold, a coherence length as long as 14 m in is obtained in Michelson interference experiments.

50448 Device and method for noresonantly Raman shifting ultraviolet radiation. Loree, T.R.; Barker, D.L. (to Department of Energy). US Patent 4,144,464. 13 Mar 1979. Filed date 25 Jan 1978. 8p.

PAT-APPL-872,292.

The invention discloses a device and method for nonresonantly Raman shifting broad band uv excimer laser radiation, which enhances preselected Stokes signals by varying the pressure of the Raman scattering medium, the focal interaction length of the incident radiation within the Raman scattering medium and its power density level. Gaseous molecular H_2, D_2, CH_4 (methane), HD and mixes thereof, and liquid N_2 are used as the Raman scattering medium to frequency shift the outputs of high power KrF and ArF lasers. A cable fed discharge with an unstable resonant cavity configuration is utilized to produce the output laser power levels required for operation.

50449 Modelling laser ionisation. Goldberg, A.; Shore, B.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *J. Phys., B (London);* **11**: No. 19, 3339-3347(14 Oct 1978).

The detailed dynamics of an idealised photoionisation process is considered by examining numerical solutions to a model of monochromatic photoionisation: a one-dimensional single bound-state square well. Exponential decay of the bound-state probability is found as would occur when modelling photoionisation by a complex energy operator. Oscillations are also observed in the bound-state probability at the driving frequency; these originate in oscillatory localised motion of the probability packet as would be expected for a classical particle driven by an oscillatory field. It is further found that when excitation frequencies are slightly above threshold and the interaction is sufficiently intense, slowly modulated departures from exponential decay occur. These originate in the action of the dipole force over large distances.

50450 Scalable, high power laser cavity for static metal vapor laser media. Kan, T. (to Department of Energy). US Patent Application 943,270. 15 Sep 1978. 12p.

The invention discloses a laser cavity for laser media requiring either interaction with the cavity walls or thermal diffusion for operability, which comprises a cavity volume of one or more concentric annular cells of a thickness and length permitted by the operability condition and conical reflective optical elements defining paths through the cavity. The advantage of such a system is that its volume and therefore its output is scalable by increasing the radial dimension of the cavity.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 49942, 49969

50451 Stability of one-step methods in transient nonlinear heat conduction. Hughes, J.R. (California Inst. of Tech., Pasadena (USA). Div. of Engineering and Applied Science). pp B2/10 1-6 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of the present work is to ascertain practical stability conditions for one-step methods commonly used in transient nonlinear heat conduction analyses. In this paper the concepts of stability, appropriate to the nonlinear problem, are thoroughly discussed. They of course reduce to the usual stability critierion for the linear, constant coefficient case. However, for nonlinear problems there are differences and theses ideas are of key importance in obtaining practical stability conditions. Of particular importance is a recent result which indicates that, in a sense, the trapezoidal and midpoint families are equivalent. Thus, stability results for one family may be translated into a result for the other. The main results obtained are: The stability behaviour of the explicit Euler method in the nonlinear regime is analogous to that for linear problems. In particular, an a priori step size restriction may be determined for each time step. The precise time step restriction on implicit conditionally stable members of the trapezoidal and midpoint families is shown not to be determinable a priori. Of considerable practical significance, unconditionally stable members of the trapezoidal and midpoint families are identified. All notions of stability employed are motivated and defined, and their interpretations in practical computing are indicated.

50452 High intensity heat pulse problem. Yalamanchili, R. (Rock Island Arsenal Lab., IL (USA)) pp 2/11 1-13 of Structural mechanics in reactor technology. Vol. B. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The use of finite-difference methods for the solution of partial differential equations is common in both design and research and development because of the advance of computers. The numerical methods for the unsteady heat diffusion equation received most attention not only because of heat transfer problems but also happened to be the basis for any study of parabolic partial differential equations. It is common to test the heat equation first even the methods developed for complex nonlinear parabolic partial differential equations arising in fluid mechanics or convective heat transfer. It is concluded that the finite-element method is conservative in both stability and monoscillation characteristics than the finite-difference method but not as conservative as the method of weighted-residuals. Since the finite-element is unique because of Gurtin's variational principle and numerous finite-differences can be constructed, it is found that some finite-difference schemes are better than the finite-element scheme in accuracy also. Therefore, further attention is focused here on finite-difference schemes only. Various physical problems are considered in the field of heat transfer. These include: numerous problems in steady and unsteady heat conduction; heat pulse problems, such as, plasma torch; problems arising from machining operations, such as, abrasive cut-off and surface grinding.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 50395

50453 (IS-M—211) Surface-crack characterization by use of dynamic photoelastic spectroscopy. Zachary, L.W.; Burger, C.P.; Schmerr, L.W.; Singh, A. (Ames Lab., IA (USA); Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). 1979. Contract W-7405-ENG-82. 19p. (CONF-790503—2). P 02/MF A01.

From Spring meeting of society for experimental stress analysis; San Francisco, CA, USA (20 May 1979).

Ultrasonic surface waves (Rayleigh waves) have their energy confined to a small region near the boundary on which they propagate. In many testing situations these waves can be used as a nondestructive evaluation (NDE) tool to effectively locate surface or near-surface flaws. There has been very little work done, however, on actually using these surface waves to characterize the important

physical parameters of flaws. This is primarily because amplitude measurements have been traditionally used in NDE to estimate the importance of a flaw and these measurements give unreliable results when the flaw is at or near a surface. Much of the difficulty stems from the fact that when a Rayleigh wave interacts with a surface flaw, a very complicated set of secondary reflected and transmitted waves are produced. These waves often overlap and interfere with one another and develop a total pattern that is extremely difficult to interpret. To quantitatively characterize surface flaws using Rayleigh waves, therefore, it is necessary to use more than amplitude information and to evaluate which secondary waves are most important. The primary purpose of the paper is to demonstrate that a combination of dynamic photoelasticity and spectroscopic techniques offers a promising means of accomplishing both of these tasks.

50454 Acoustic imaging system. Smith, R.W. (to Department of Energy). US Patent 4,145,680. 20 Mar 1979. Filed date 18 Oct 1977. 10p.

PAT-APPL-843,182.

The invention discloses an acoustic imaging system for displaying an object viewed by a moving array of transducers as the array is pivoted about a fixed point within a given plane. A plurality of transducers are fixedly positioned and equally spaced within a laterally extending array and operatively directed to transmit and receive acoustic signals along substantially parallel transmission paths. The transducers are sequentially activated along the array to transmit and receive acoustic signals according to a preestablished sequence. Means are provided for generating output voltages for each reception of an acoustic signal, corresponding to the coordinate position of the object viewed as the array is pivoted. Receptions from each of the transducers are presented on the same display at coordinates corresponding to the actual position of the object viewed to form a plane view of the object scanned.

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 50267

50455 (ORNL/Sub—7504/3) **Recessed light fixture test facility.** Yarbrough, D.W.; Yoo, K.T.; Koneru, P.B. (Tennessee Technological Univ., Cookeville (USA). Dept. of Engineering Science). Jul 1979. Contract W-7405-ENG-26. 55p. P 04/MF A01.

Test results are presented for the operation of recessed light fixtures in contact with loose fill cellulose insulation. Nine recessed fixtures were operated at different power levels in attic sections in which loose fill cellulose was purposely misapplied. Cellulose insulation was introduced into the ceiling section by pouring to depths of up to nine inches. Maximum steady state temperatures were recorded for 485 combinations of the variables insulation depth, fixture power, and attic temperature. Results are included for operation of fixtures in the absence of cellulose and with barriers to provide needed clearance between the cellulose insulation and the powered fixtures. Observed temperatures on the electrical power cable attached to a fixture and ceiling joists adjacent to powered fixtures are reported. Examination of the data shows excess operating temperatures are encountered when powered fixtures are covered by three inches of loose fill insulation. Dangerous temperatures resulting in fires in some cases were recorded when covered fixtures were operated at above rated power levels. A preliminary analysis indicates that ceiling side heat transfer accounts for 85 to 90% of the heat dissipation from powered fixtures covered by three inches of loose fill cellulosic insulation.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 50482

50456 Stable, inexpensive, low-frequency sine wave generator using digital techniques. Podolske, J. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **50**: No. 8, 1010-1012(Aug 1979).

Presented is a circuit for the generation of low-frequency (0.001 Hz to 63 kHz) sine waves possessing stable amplitude and frequency characteristics using digital techniques. The circuit produces a 32-step approximation to a sine wave at a frequency 1/32nd of the selected digital time-base frequency. Also presented are a crystal-controlled time base to drive the generator, and an active filter for removing the high-order harmonics produced by the generator. Advantages of the digital sine wave generator over analog oscillator techniques are described.

50457 Stable sinusoidal driver circuit for tuning fork choppers. Podolske, J. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **50**: No. 8, 1025-1027(Aug 1979).

A circuit is presented which can drive tuning fork choppers, such as the Bulova L40 and L2 series. The advantages of this circuit over the factory-supplied 5A-type driver are better drive-amplitude stability, freedom from drift due to line-voltage variations, and a cleaner, transient-free sinusoidal reference signal. Test results indicate an improvement in long-term stability by as much as a factor of 4.

50458 Missing pulse detector for a variable frequency source. Ingram, C.B.; Lawhorn, J.H. (to Department of Energy). US Patent 4,142,159. 27 Feb 1979. Filed date 7 Nov 1977. 4p.

PAT-APPL-849,200.

A missing pulse detector is provided which has the capability of monitoring a varying frequency pulse source to detect the loss of a single pulse or total loss of signal from the source. A frequency-to-current converter is used to program the output pulse width of a variable period retriggerable one-shot to maintain a pulse width slightly longer than one-half the present monitored pulse period. The retriggerable one-shot is triggered at twice the input pulse rate by employing a frequency doubler circuit connected between the one-shot input and the variable frequency source being monitored. The one-shot remains in the triggered or unstable state under normal conditions even though the source period is varying. A loss of an input pulse or single period of a fluctuating signal input will cause the one-shot to revert to its stable state, changing the output signal level to indicate a missing pulse or signal.

50459 Fiber optic solid state switch. Thuot, M.E. (to Department of Energy). US Patent Application 945,376. 25 Sep 1978. 5p.

In accordance with the invention, a remotely controlled solid state relay is provided with a fiber optic input. This relay is powered by the circuit being controlled. Therefore, no external power supply is required. A trigger circuit, powered from the ac line, is actuated by back biased PIN diode. The trigger circuit controls a switch comprising a pair of silicon controlled rectifiers, connected in series with the ac source and the load.

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 50285

50460 (RLO—1053-T1) **Tacoma Refuse Fired Combustor Study for the City of Tacoma, Washington.** Bell, R.R. (Durham, Anderson, Freed/HDR, Seattle, WA (USA)). Mar 1978. Contract EC-77-C-06-1053. 232p. P 11/MF A01.

The purpose of this study was to examine the feasibility of using refuse-derived fuel and other waste fuels to fire a central energy plant to meet the heating and cooling needs of the Central Business District of Tacoma, with the possibility of marketing steam and/or electricity as a by-product. The study entailed examination of: the existing conditions; site selection; area waste availability; steam and hot water demands; the technical, environmental, and economic aspects of such a heating plant; conceptual design; overall feasibility studies; and financing, implementation and operation plans. It was the conclusion of the Tacoma Refuse Fired Combustor Study that an agreement be negotiated with the St. Regis Paper Company, Lumber and Plywood Division to furnish steam to the district heating system. If this cannot be accomplished, the construction of a central energy plant burning waste-type fuels is technically viable, but economic feasibility is dependent upon supplementing the central business district (CBD) heating load with the industrial steam load of the St. Regis Company. If equitable negotiations cannot be completed with St. Regis and the City of Tacoma, the CBD heating load would be served more cost effectively with individual electric boilers. (LCL)

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 49850

50461 (ORNL/TM—6633) **Assessment of the state of the art of pressurized fluidized bed combustion systems.** Fraas, A.P.; Graves, R.L.; Lackey, M.E. (Oak Ridge National Lab., TN (USA)). 16 May 1979. Contract W-7405-ENG-26. 56p. P 04/MF A01.

This report was prepared at the request of the Tennessee Valley Authority (TVA) to clarify the development status of the pressurized fluidized bed combustor (PFBC) and to place in perspective the problems which are yet to be solved before commercialization of the concept is practical. The report is viewed as preliminary to a more complete and comprehensive work to be carried out

during FY 1979. An evaluation of the PFBC concept cites potential advantages over atmospheric pressure fluidized bed combustors (AFBC) in the areas of combustion efficiency, sulfur retention, furnace design, power plant efficiency, and others. The key disadvantage of unproven hot gas cleanup and associated gas turbine technology is discussed in considerable detail. A survey of existing and developing PFBC experimental facilities is presented plus some results from the experimental programs. Recent design studies for full-sized PFBC power plants are reviewed with emphasis on key design parameters. Results for similar AFBC design studies are presented in contrast. The general conclusion drawn from this preliminary survey is that the potential advantages of the PRBC used in conjunction with a high-temperature [850°C (1560°F)] gas turbine will be difficult to realize due primarily to the formidable task of developing adequate hot gas cleanup and turbine systems, and due to the anticipated high cost of these systems.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 49465

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 49686, 49687

50462 (PNL-SA—7115, pp 353-365) **Thermal fouling rates of 90:10 copper—nickel and titanium in seawater service.** Ritter, R.B.; Suitor, J.W. (Heat Transfer Research, Inc., Alhambra, CA); Cypher, G.A. Aug 1978.

From Conference on ocean thermal energy conversion-biofouling and corrosion problems; Seattle, WA, USA (10 Oct 1977).

Since January 1974, a Heat Transfer Research, Inc. (HTRI) Portable Fouling Research Unit has been operating on untreated seawater at the Haynes Steam Plant, of the Los Angeles Department of Water and Power, Long Beach, California, under the direction of International Copper Research Association, Inc. (INCRA). In nine tests, heated rods of 90:10 copper—nickel and titanium were operated simultaneously at identical conditions to determine the effect of seawater velocity and surface temperature on fouling rates. Operating conditions were selected to bracket those of a seawater-cooled power plant surface condenser which currently operates at a velocity of 6 ft/sec (1.8 m/sec) and a surface temperature of 77°F(25°C). Velocities of 2, 4, 6, and 8 ft/sec (0.6, 1.2, 1.8, and 2.4 m/sec) were tested at surface temperatures of 80°F (27°C). Surface temperatures of 80, 100, 130, and 150°F (27, 38, 54, and 66°C) were tested at a velocity of 6 ft/sec (1.8 m/sec). At 80° (27°C) surface temperature, titanium fouled at a steady rate; while 90:10 CuNi fouled at the same rate for short periods, followed by loss of deposits when the binding organism died. At 100°F (38°C) and 6 ft/sec (1.8 m/sec), both materials showed steady fouling rates of similar magnitude. For titanium, fouling rate at 100°F (38°C) was about half that at 80°F (27°C). For 90:10 CuNi, fouling rates were similar for both temperatures. The copper alloy did not exhibit the build-up and fall-off at 100°F (38°C) that it did at 80°C (27°C). Analyses of deposits showed the usual bound silt on titanium and primarily corrosion products on the copper alloy. Apparently, the combination of higher temperature and protective copper film almost eliminated biofouling on the copper alloy at the higher temperature.

BRAYTON

REFER ALSO TO CITATION(S) 50288

STIRLING

REFER ALSO TO CITATION(S) 50283, 50288

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 50905

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 50498, 50499, 50500

50463 (SAND—79-0597) **SNEER: A digital computer program for the simulation of charged particle beams and electrostatic lenses.** Boers, J.E. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 35p. P 03/MF A01.

SNEER has been found to be a powerful tool for the analysis of charged particle beams and trajectories. Inclusion of relativistic trajectory computations and the ability to include dielectrics in the potential relaxation enables the program to handle virtually any type of beam configuration not including a source - such as a cathode. Examples shown here have produced results within a few percent of exact theoretical and experimental results. A sample input data set is presented for still another application of the program. Here, trapped electron orbits are traced in electric and magnetic fields in an ion gauge configuration.

AUXILIARIES AND COMPONENTS

ION SOURCES

50464 **High-intensity carbon ion injector.** Humphries, S. Jr.; Mendel, C.W. Jr.; Kuswa, G.W.; Goldstein, S.A. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **50**: No. 8, 993-996(Aug 1979).

An injector of intense beams of carbon ions is described. The device uses an array of carbon plasma guns to inject ions directly into a magnetically insulated acceleration gap. Ion currents exceed 3 kA with beam energies between 100 and 300 keV (for C^+) and 200 and 600 keV (for C^{++}) over a 700-ns pulselength.

INJECTION AND EXTRACTION SYSTEMS

REFER ALSO TO CITATION(S) 50528

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 50486, 50487, 50488, 50489, 50490, 50491, 50492, 50493, 50494, 50495, 50497, 50501, 50503, 50505, 50506, 50507, 50508, 50509, 50510, 50511, 50512, 50513, 50514, 50515, 50516, 50517, 50518, 50519, 50520, 50521, 50523, 50524, 50525, 50527, 50537, 50683, 50684

50465 (ANL—78-XX-68) **ATLAS: a proposal for a precision heavy ion accelerator at Argonne National Laboratory.** (Argonne National Lab., IL (USA)). Feb 1978. Contract W-31-109-ENG-38. 302p. P 14/MF A01.

The objective of the proposed Argonne Tandem-Linac Accelerator System (ATLAS) is to provide precision beams of heavy ions for nuclear physics research in the region of projectile energies comparable to nuclear binding energies (5-25 MeV/A). By using the demonstrated potential of superconducting rf technology, beams of exceptional quality and flexibility can be obtained. The system is designed to provide beams with tandem-like energy resolution and ease of energy variation, the energy range is comparable to that of a ~ 50 MV tandem and, in addition, the beam will be bunched into very short (~ 50 psec) pulses, permitting fast-timing measurements that can open up major new experimental approaches.

50466 (ANL—78-XX-68(Add.)) **Addendum to a proposal for ATLAS: a precision heavy-ion accelerator at Argonne National Laboratory.** (Argonne National Lab., IL (USA)). Dec 1978. Contract W-31-109-ENG-38. 92p. P 05/MF A01.

This revised proposal for the construction of the Argonne Tandem-Linac Accelerator System (ATLAS) is in all essentials the same as the proposal originally presented to NUSAC in March 1978. The only differences worth mentioning are the plan to expand the experimental area somewhat more than was originally proposed and an increased cost, brought about principally by inflation. The outline presented is the same as in the original document, reproduced for the convenience of the reader. The objective of the proposed Argonne Tandem-Linac Accelerator System (ATLAS) is to provide precision beams of heavy ions for nuclear physics research in the region of projectile energies comparable to nuclear binding energies (5 to 25 MeV/A). By using the demonstrated potential of superconducting rf technology, beams of exceptional quality and flexibility can be obtained. The proposed system is designed to provide beams with tandem-like energy resolution and ease of energy variation, and the energy range is comparable to that of a ~ 50 MV tandem. In addition, the beam will be bunched into very short (~ 50 psec) pulses, permitting fast-timing measurements that can open up major new experimental approaches.

50467 (BNL—50885, pp 16-18) **Multiple Coulomb scattering and γ conversions in fiber scintillators vs multiwire proportional and drift chambers.** Flaminio, V. (Univ., Pisa, Italy). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Compared with multiwire proportional and drift chambers, fiber scintillators have the advantages of faster response and smaller deadtime, but the short radiation length of a typical scintillator introduces two new problems: γ conversions (and therefore higher background) and multiple Coulomb scattering (and hence poorer momentum and angular resolution). Here we try to analyze these problems and to see what types of experimental configurations are compatible with scintillator hodoscopes and what types are more conveniently set up with wire chambers.

50468 (BNL—50885, pp 19-27) **Survey of experiments for use of fine-grained hodoscopes.** Romanowski, T. (Ohio State Univ., Columbus); Ling, T.Y.; Flaminio, V.; Takasaki, F.; Borenstein, S. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The high rate of particles per unit area and time produced at ISABELLE at full luminosity (10^{33} cm^{-2} sec^{-1}) calls for the usage of devices with the shortest space and time resolution. Hodoscopes made of thin scintillation fibers will satisfy such requirements. The short resolution time (3 to 4 nsec) of the scintillator can provide a fast trigger and strobing gates for shower detectors used in same experiment. It will also keep the number of accidental coincidences to a minimum. If read out with microchannel plates or avalanche photodiodes, such hodoscopes can be readily used in a magnetic field. Their fine granularity could be used to provide spatial position information for track reconstruction or for pretrigger schemes based on crude pattern recognition. For example, with a luminosity of 10^{33} cm^{-2} sec^{-1}, the expected particle yield is about 10^8 particles/sec in a solid angle covering the polar angular region of $45^0 <$ theta $< 135^0$. Most of these particles produced, however, have very low transverse momentum (p/sub perpendicular to/ $<$ 5 GeV/c). Therefore, the hodoscope information could be used to provide a pretrigger rejecting low p/sub perpendicular to/ tracks on the basis of a crude determination of the sagitta of the trajectory in a magnetic field. Another example of a case in which fine granularity is essential is that of small-angle scattering experiments, which require angular resolution of a fraction of a milliradian. A brief survey of a few typical detectors discussed in previous Summer Workshops is presented. Its purpose is to look into the usage of fine-grain hodoscopes in each detector configuration. Four cases are considered: the axial-field magnetic spectrometer (ISR version), the lepton detector, the wide-angle spectrometer, and the detector for small-angle scattering.

50469 (BNL—50885, pp 28-32) **Particle detection by secondary electron emission from low-density KC1.** DiNardo, R. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The development of advanced particle detectors for the ISABELLE facility is now under consideration. One type of detector, proposed here, utilizes the secondary electron emission from a low-density KC1 layer as the particle goes through the layer. This type of detector is interesting for several reasons: (1) Since the secondary electrons are created only as a result of incident particle interaction, the mechanism is applicable for very fast detectors. (2) Because of the low density of the target ($\sim$ 0.02 g/cc), more than one detector can be placed along the particle trajectory in order to provide both space and time resolution. (3) Since the secondary emission depends on the energy loss of the particle, it is possible to determine the velocity and identity of minimum ionizing particles. (4) The secondary electron yield (usually much $>$ 1 per event) can be coupled with other detection mechanisms.

50470 (BNL—50885, pp 33-42) **Avalanche photodiodes for ISABELLE detectors.** Strand, R.C. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

At ISABELLE some requirements for detecting bursts of photons are not met by standard photomultiplier tubes. The characteristics of immunity to magnetic fields, small size (few mm), low power consumption ($\sim$ 100 mW), insensitivity to optical overloads, and wide dynamic range ($\sim$ 60 dB) are achieved with difficulty, if at all, with PMTs. These are characteristics of the solid state avalanche photodiode (APD), the preferred detector for light-wave communications. Successful field tests with APD detectors stimulated the design of standard optical-fiber communication systems to replace wire carriers by the early 1980's. In other characteristics, i.e., counting rate, pulse-height resolution, effective quantum efficiency, detection efficiency, and reliability, bare APDs are equivalent to standard PMTs. APDs with currently available amplifiers cannot resolve single photoelectrons but they could provide reasonable detection efficiencies and pulse-height resolution for packets of $\sim$ $>$ 100 photons. Commercially available APDs can cost up to 100 times as much as PMTs per active area, but they are potentially much cheaper. Six topics are discussed: (1) detectors for light-wave communication and detectors for particles, (2) avalanche photodiodes, (3) commercially available APDs, (4) dynamic response of PMTs and bare APDs, (5) photon counting with cold APDs, and (6) conclusions and recommendations.

50471 (BNL—50885, pp 47-51) **Preliminary test results of a finely segmented iron—liquid argon hadron calorimeter.** Sessoms, A.L. (Harvard Univ., Cambridge, MA). Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

A large liquid argon—iron hadron calorimeter (LARC) has been built and tested at Fermilab. The design consists of alternating solid (high voltage) iron plates (3 mm thick) with layers of steel strips (3 mm thick and 2 cm wide) at ground potential, separated by 4-mm liquid argon gaps. This arrangement is repeated throughout the device, with alternate layers of strips having horizontal and vertical orientation. More details are given in Table 1. The finely segmented design makes possible a detailed experimental study of the properties of hadronic showers. Some results of a preliminary study of the energy, position, and angular resolution of this device are presented.

50472 (BNL—50885, pp 57-60) **Some comments on forward calorimeters.** Smith, S.D. (Brookhaven National Lab., Upton, NY); Tarnopolsky, G.J. Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

In contemplating the problems presented by the extremely high single-particle rates expected at ISABELLE, one quickly discovers that calorimeters are particularly hard to deal with. Since hadronic showers are of finite size, the favorite trick of making increasingly smaller counters in order to reduce individual counting rates does not work once the counters are of smaller size than the hadronic showers - one can only go farther away from the intersection region. Counter geometries to overcome this are discussed.

50473 (BNL—50885, pp 65-75) **Subgroup on general triggering problems.** Cutts, D. (Brown Univ., Providence, RI); Thompson, J.A.; Jensen, D.; Day, C.T.; Read, A.L.; Lesnik, A.; Koehler, P.F.M.; Sakitt, M. Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

A general description of a multilevel logic system is discussed and the question of whether there are natural structures imposed on the system by the techniques and technologies to be used is considered. As expected, the conclusions confirm what intuition had strongly suggested. A general layout of multilevel triggering is shown. It is assumed that there is a detector, and the front-end amplifier sees a rate which includes the event rate plus noise. Clearly not all elements in the detector have the same inherent resolving time. The fastest detector is expected to have a resolving time of $\sim$ 1 nsec, whereas for the slower ones it may be $\sim$ 10^2 nsec. The triggering is assumed to be done in stages.

50474 (BNL—50885, pp 120-138) **Preliminary results on tests of a Cerenkov ring imaging device employing a photoionizing PWC.** Durkin, S.; Honma, A.; Leith, D.W.G.S. (Stanford Linear Accelerator Center, CA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

It is shown that one can use photoionization techniques to obtain an image of the Cerenkov ring. Argon, N_2, neon, and helium have been tested and shown to function well as radiator media. The results for the ring radii obtained agree with previous measurements of the VUV index of refraction, and we also obtained a value for the O_2 absorption coefficient averaged in our photon energy range. The outstanding problem, however, was the disparity between the number of photons observed and the number expected. With direct measurement of the transmissions, reflectances, and efficiencies of the various components, and with the use of more sensitive amplifiers, we hope to be able to account for this difference.

50475 (BNL—50885, pp 201-204) **Day-one experimental straight sections.** Halama, H.J. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The ISABELLE vacuum system consists of a copper-clad stainless steel vacuum chamber (8.8-cm i.d.) pumped by a standard pumping station between the magnets. The distance between pumps is thus $\sim$ 5.5 m. Both the copper and stainless tubes have a wall thickness of $\sim$ 1.15 mm. In magnet-free regions Cu cladding is not necessary except possibly for reasons related to the transverse impedance problems. This note is concerned only with the experimental straight sections, i.e., the sections between quadrupoles Q1. Sector valves will be located at these points, making it possible for experimenters to replace the day-one ISABELLE chamber with their experiments. The early expected beam—beam interaction rate $R = L\sigma/\text{sub T/}$ will be $\sim$ 5 x 10^6 sec^{-1} with L = 1 x 10^{32} cm^{-2} sec^{-1} and $\sigma/\text{sub T/} = 50 \times 10^{-27}$ cm^2. Taking into account beam-gas

collisions, beam-solid collisions, and multiplicity, the beam interaction-to-background ratio should exceed 100.

50476 (BNL—50885, pp 219-222) **Proposed revision to the design for the 6 o'clock experimental area.** Brody, A. (Univ. of Pennsylvania, Philadelphia); Joestlein, H.; Koehler, P.F.M.; Read, A.L.; Marx, M.; Walker, W. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Early in this Workshop a preliminary design was presented for the experimental area located at the 6 o'clock position of the present ISABELLE site plan (ISABELLE Conventional Facilities Design, Final Report, Title 1, March 1, 1978). Problems are foreseen with three aspects of this design: (a) The 15 x 20' door is too small for the assembly detector to pass through. Because of its massive nature and resultant cost this door cannot be made large enough to meet the needs of the detectors as currently perceived and those to be designed in the future. (b) This door makes it mandatory that final assembly, testing, and later repairs of the detector be done inside the shielded building. These activities will conflict with operation of the storage ring, both during initial commissioning of the machine and during subsequent operation of experiments in the other intersection regions. (c) The 5' step in the floor elevation encountered upon entering the present experimental hall will necessitate time-consuming and costly rigging of heavy, yet delicate apparatus just prior to installation. A revised design is proposed for this experimental area which will eliminate the first two problems and greatly alleviate the third, and will provide other benefits as well, at essentially the same overall cost.

50477 (BNL—50885, pp 226-234) **Comments on the design of the four o'clock (and twelve o'clock) experimental areas.** Aronson, S.; Foley, K.; Marx, M. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

During the first week of this Workshop a preliminary design was described by various members of the BNL staff for the two open areas at the 4 o'clock and 12 o'clock positions of the present ISABELLE site plan. In addition, a possible scenario for the future development of these areas is presented in some detail. In this paper, three particular aspects of these open experimental areas are discussed: (1) our recommendations for the initial phase of construction of these open areas (especially the 4 o'clock area), since BNL intends to freeze the plan for its initial construction phase in the very near future, (2) a possible scenario for early, "smallish," "nook-and-cranny" experiments which may be located in these areas at the time ISABELLE is first brought into operation, and (3) our thoughts on possible longer-term scenarios for future development of the 4 o'clock and 12 o'clock areas.

50478 (BNL—50885, pp 242-244) **Report of the dipole facility subcommittee.** Ozaki, S. (Brookhaven National Lab., Upton, NY); Tannenbaum, M. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

With the work of team D in the June simulation exercise as a starting point, a large dipole facility at ISABELLE was considered. Other dipoles, such as a 5-m-diam circular dipole with a 2.5-m gap and a 8-m-diam dipole with a 4-m gap have been considered. A facility at ISABELLE should be reasonably useful for a variety of physics objectives; flexible in detector configuration to fulfill the above goal; easy to service to minimize downtime; and capable of being upgraded for second-generation experiments.

50479 (BNL—50885, pp 245-248) **Toroidal magnets.** Pope, B.G. (Princeton, Univ., NJ); Rosenson, L.; Taylor, T.M. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The use, at ISABELLE, of magnets in which the magnetic field is always in the azimuthal direction about the line of the colliding beams has been considered. This toroidal configuration has the advantage that the field is used to maximal effect in that it is perpendicular to the direction of particles originating from the interaction diamond. The coils necessary to produce such a field are shown schematically. ISABELLE energies are expected to require bending powers > 1 T-m, and these discussions have been confined to superconducting toroids. In this context, three possible configurations were examined: a "thin" continuous coil toroid, a "lumped" coil version in which many coils are contained in one common cryostat, and a "separate coil" version in which each coil is a separate entity (i.e., has its own cryostat). These different configurations are reflected in the azimuthal acceptance or "transparency" that can be achieved and also imply differences in the accessibility of any detectors. This subgroup concluded that, while azimuthal acceptances of up to $\sim$ 80% could be obtained with any of the above versions, this lack of transparency was a restriction for the detailed study of hadron or electron final states. Because of this restriction in the physics that could be studied with the device, the toroid is not thought to be competitive with the large dipole, solenoid, or axial field magnet "facilities" discussed elsewhere in these Proceedings, but rather is seen as a sensitive, modest-resolution, first-generation experiment.

50480 (BNL—50885, pp 295-302) **Open areas and open access.** Thorndike, A.M. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The main objective of the two open areas in the present ISABELLE design has been to provide flexibility with respect to the size and shape of experimental equipment that would eventually be installed there. No permanent building would be installed initially. One possibility would be to enclose each experiment in a temporary structure that would provide weatherproofing and shielding; another possibility would be to erect a permanent building at a later time, when experience has made the needs clearer than they are at present. The secondary objective of the design of open areas has been to keep initial costs as low as practicable. Another objective might be added, however, which we indicate by the term "open access." This note will explore this idea and some design concepts based on it. In the ISABELLE 1977 summer workshop there was considerable discussion of the importance of techniques for inserting large pieces of experimental equipment quickly and removing them with equal ease and speed. Since enclosed halls have certain restrictions in this respect, open areas may be helpful in providing this feature. If the mechanical and electrical aspects could be handled quickly, one might even attempt to reduce the time spent on bureaucratic procedures in order to expedite the introduction of new experiments and new ideas in these areas.

50481 (CONF-790728—1) **Heavy ion target area fast neutron dose equivalent rates.** Ohnesorge, W.F.; Butler, H.M.; Fulmer, C.B.; Mosko, S.W. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 9p. P 02/MF A01.

From 24. annual meeting of the Health Physics Society; Philadelphia, PA, USA (7 Jul 1979).

Fast neutron dose equivalent rates were measured for targets bombarded with a variety of heavy-ion beams over a wide range of energies. These data should be useful to those developing policies which allow personnel to enter accelerator areas during beam on periods. (GHT)

50482 (LA-UR—79-1221) **Front-end data processing using the bit-sliced microprocessor.** Machen, D.R. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790549—4). P 02/MF A01.

From Conference on computerized data - acquisition systems in particle and nuclear physics; Santa Fe, NM, USA (14 May 1979).

A state-of-the-art computing device, based upon the high-speed bit-sliced microprocessor, was developed into hardware for front-end data processing in both control and experiment applications at the Los Alamos Scientific Laboratory. The CAMAC Instrumentation Standard provides the framework for the high-speed hardware, allowing data acquisition and processing to take place at the data source in a CAMAC crate. 5 figures.

50483 (LBL—9152) **Data acquisition using PDP-11 and MBD branch driver at L.B.L.** Harvey, E.H. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 7p. (CONF-790549—10). P 02/MF A01.

From Conference on computerized data - acquisition systems in particle and nuclear physics; Santa Fe, NM, USA (14 May 1979).

A data acquisition system was designed and preliminary versions implemented for physics experiments at LBL. It utilizes an MBD microprogramed branch driver and a PDP-11 operating under RSM-11M. An MBD executive is used to implement software breakpoints within the MBD. The PDP-11 data acquisition buffer management scheme allows for multiple tasks dynamically accessing the data stream. Emphasis is directed towards future expansions. High data rates are also emphasized. 2 tables.

50484 (LBL—9182) **Minus 3: a general purpose data acquisition system at LBL's 88"-cyclotron and superhilac.** Maples, C.; Sivak, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 9p. (CONF-790549—15). P 02/MF A01.

From Conference on computerized data - acquisition systems in particle and nuclear physics; Santa Fe, NM, USA (14 May 1979).

MINUS 3 is a general, multi-tasked data acquisition package operating on the ModComp IV/25 computers at both the 88"-Cyclotron and SuperHILAC. It currently can acquire data via three different channels: interrupt; serial DMA link; and remote slave units for histogram type data. Two additional acquisition paths, CAMAC (with programmable differential branch drivers) and MODACS (for multiple CPU linkages and control) are scheduled to be added in the near future. The package operates in a prioritized, time-available mode which permits it to dynamically adapt to microscopic data rate

structures due to beam characteristics at different accelerators. Special hardware has been added to the graphics system to provide enhanced high-speed interactive capability. The program framework is also designed as a parasitic environment in which users may, in parallel, attach their own specialized and independent code.

50485 (ANL-Trans—1167) **Development and testing of an induction furnace for the production of high-temperature vapors for absorption spectroscopy studies.** Radtke, E.R. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.). May 1979. Translation of BONN-IR—75-13, April 1975. 48p. P 03/MF A01.

Thesis.

The two electron synchrotrons of Bonn are powerful sources of synchrotron radiation which is utilized by the Bonn Synchrotron Radiation Group in collaboration with the Imperial College of London for absorption experiments with gases and vapors. The vacuum uv region with wavelengths of 2000 A to about 10 A is of particular interest. This region contains the excitation and ionization energies of the inner electron shells. Absorption experiments are carried out with the quasi-continuum of synchrotron radiation as the background and an absorption cell between the synchrotron and spectroscope. The absorption cell consists of furnaces in which nongaseous elements can be vaporized. A measurement of photon absorption cross-sections in the order of 1 Mb = 10^{-18} cm^2, which may be considered typical, requires an integral particle density of $\int N(s)ds \sim 10^{18}/cm^2$. With an approximately homogeneous density distribution and an absorption cell length X = 42 cm, a vapor pressure of 1 to 2 torr corresponds to this particle density. The resistance furnaces utilized thus far only allowed a determination of elements which have a vapor pressure of at least 1 torr at a temperature of 1000°C. The objective of this study therefore is to develop an induction furnace with an efficiency of 80%, so that a 42 cm long furnace pipe can be heated to a temperature of about 2300°C. Two problems must be solved: (1) It is necessary to investigate theoretically how the efficiency of an induction furnace of finite length can be maximized, since the results known from literature are incorrect. (2) Using the theoretical findings, the induction furnace must be constructed and tested.

STORAGE RINGS

REFER ALSO TO CITATION(S) 50468, 50469, 50470, 50472, 50473, 50474, 50475, 50476, 50477, 50478, 50479, 50480

50486 (BNL—50885) **Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.** (Brookhaven National Lab., Upton, NY (USA)). Feb 1979. Contract EY-76-C-02-0016. 456p. P 20/MF A01.

Three general areas are covered by the workshop. These are detectors, experimental areas and data handling. Fifty-seven individual items were prepared separately for the data base. Several brief contributions were included in the workshop proceedings but were not prepared separately. (GHT)

50487 (BNL—50885, pp 3-8) **Detector development summary.** Platner, E.D. (Brookhaven National Lab., Upton, NY); Williams, H.H. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

This year's Summer Study brought great enthusiasm to the problems of detector development. In past years the especially difficult problem of detecting and identifying particles in the high multiplicity and high event rate environment anticipated at ISABELLE had at times seemed nearly impossible to solve. Very significant progress has been made during the year on a number of questions raised last summer. This summer again a number of specific areas needing continued research and development became apparent. Among these are (1) further measurements on the lifetime, pulse-height resolution, and position resolution of multiwire proportional drift chambers (particularly at high rates); (2) energy and timing resolution of thin-plate calorimeters, particularly uranium plate with scintillator sampling and iron plate with both scintillator and MWPC sampling; (3) photoionization detectors, image intensifiers, and new types of transition radiators; (4) scintillating optical fibers, avalanche photodiodes, secondary emission devices, and microchannel plates; and, perhaps most important, (5) triggering and hardware processors.

50488 (BNL—50885, pp 10-15) **Detection system using scintillating optical fibers and image tube readout.** Alspector, J. (Brookhaven National Lab., Upton, NY); Borenstein, S. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The hodoscope subgroup has studied a detection system consisting of bundles of optical fibers with readout via image tubes. The basic building block is an optical fiber with a scintillator inner core. The inner core has refractive index n/sub o/ (1.58 for plastic scintillator), and the outer sheath has a low index (~ 1.4). Light is created in the core by passage of a particle track; if the light strikes the sheath at an angle greater than the critical angle phi/sub c/, it is trapped in the fiber until it finds its way to the photon detector.

50489 (BNL—50885, pp 44-46) **Proportional wire calorimeters at ISABELLE.** Matthews, J.A.J. (Johns Hopkins Univ., Baltimore, MD). Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Gas calorimeters have recently increased in popularity because they provide a simple method of achieving a high degree of calorimeter segmentation with only a modest loss in energy resolution compared with liquid argon or scintillator calorimeters. High radiation levels at ISABELLE will result in gas calorimeter lifetimes similar to those of MWPCs, although the intermediate speed of these devices may cause some resolution degradation due to signal pileup. Schemes for calibration and monitoring gas calorimeters in situ must be evolved and will presumably utilize a combination of pulsers, imbedded ^{55}Fe sources, etc. Most of the recent development work on gas calorimeters has been centered on electromagnetic (em) calorimetry for large detectors at CESR and PEP. Data on the performance of gas calorimeters are given and compared with the liquid argon results of Hitlin et al. The hadronic gas calorimeter results of Anderson et al. are shown along with typical energy resolution results from various scintillator and liquid argon steel calorimeters.

50490 (BNL—50885, pp 52-56) **Uranium-scintillator device.** Smith, S.D. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The calorimeter subgroup of the 1977 ISABELLE Summer Workshop strongly recommended investigation of the uranium-scintillator device because of its several attractive features: (1) increased resolution for hadronic energy, (2) fast time response, (3) high density (i.e., 16 cm of calorimeter per interaction length), and, in comparison with uranium—liquid argon detectors, (4) ease of construction, (5) simple electronics, and (6) lower cost. The AFM group at the CERN ISR became interested in such a calorimeter for substantially the same reasons, and in the fall of 1977 carried out tests on a uranium-scintillator (U-Sc) calorimeter with the same uranium plates used in their 1974 studies of the uranium—liquid argon (U-LA) calorimeter. The chief disadvantage of the scintillator test was that the uranium plates were too small to fully contain the hadronic showers. However, since the scintillator and liquid argon tests were made with the plates, direct comparison of the two types of devices could be made.

50491 (BNL—50885, pp 61-63) **New ideas for calorimetry.** Erwin, A. (Univ. of Wisconsin, Madison); Gordon, H.; Limon, P.; Matthews, J.A.J.; Sessoms, A.L.; Tarnopolsky, G.; Smith, S.D. Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Three new ideas which resulted in proposals for support from the ISABELLE Detector Development Foundation are outlined: (1) improved resolution in iron-scintillator hadron calorimetry; (2) dual-purpose calorimeters and magnet pole pieces or flux returns; and (3) avalanche photodiodes for finely segmented devices. (GHT)

50492 (BNL—50885, pp 76-80) **Triggering at ISABELLE: the first 200 nanoseconds.** Abshire, G. (SUNY, Stony Brook, NY); Kondo, K.; Sculli, J.; Johnson, R.A.; Morris, G.R. Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

In a typical experiment, a certain small number of signals will come into an electronics trailer on cables that are as short as possible and have propagation velocities as high as possible. With these signals a fast decision will be made as to whether the rest of the information coming in on the slower, longer cables should be further processed or not. The typical length of time for this decision is 200 ns. In this paper, some of the problems arising during that first 200 ns are confronted, and some examples of attempts to solve those problems are given.

50493 (BNL—50885, pp 81-95) **Report of the subgroup on fast processing.** Gibbard, B.G. (Cornell Univ., Ithaca, NY); Kirsch, L.E.; Moneti, G.; Plano, R.J.; Rabin, M.S.Z.; Willen, E. Feb 1979.

In Proceedings of the ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The flow of data and the simultaneous processing method to reduce the 10^7 to 10^8 triggers per second expected at ISABELLE to a number of events on the order of 10 to 100 per second which would be written on magnetic tape are examined. It is assumed that within 100 ns of the event, a fast pretrigger would have reduced the data rate to at most 10^7 per second. At that point, data from all sense elements in the experiment are fed into a 1-μs-long pipeline. Within the first 1 μs (while the data are in the first pipeline) it is assumed

that another level of triggering reduces the trigger rate to at most 10^6 per second. The data are then fed into a second pipeline which is 50 μs long. During the 50 μs the data are in the second pipeline, a more sophisticated level of triggering (slow trigger) reduces the trigger rate to a level that can be handled by standard data processing techniques (microprocessors or larger machines), i.e., 10^2 to 10^3 per second. First, the pipelines and the buffer between them, a sequential address memory, are described and then several alternative schemes for the pretrigger and slow trigger are presented.

50494 (BNL—50885, pp 96-119) **Cerenkov counters at ISABELLE.** Ashford, V. (Brookhaven National Lab., Upton, NY); Etkin, A.; Honma, A.; Kostoulas, I.; Lanou, R.; Watts, T. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Particle mass identification capability will be very important for much of the physics at ISABELLE. It will be required for studying quantum number flow in quark—quark scattering (jet and high p/sub t/ physics), hadronic decays of W's and Z's, and "onium" states. It will be essential for detecting and studying "naked flavor" states and generally required or at least very useful for most hadronic physics at ISABELLE. The large all-purpose detectors envisioned for ISABELLE require particle identification covering up to 4π solid angle with high multiplicity capability, high rate capability, insensitivity to high magnetic fields, and large dynamic range (1 to 400 GeV/c). In addition, it would be desirable to have this information for on-line event selection. At present there are only four practical methods for doing charged hadron identification: time-of-flight, dE/dX (ionization sampling), transition radiation, and Cerenkov radiation. All these methods need independent momentum determination and are effective over only limited kinematic ranges. Although the status and foreseeable development of these techniques are discussed at length elsewhere in these Proceedings, their expected capabilities are summarized here in order to compare them with Cerenkov techniques. For the sake of argument a 4π steradian detector with an inner radius of 2m is assumed.

50495 (BNL—50885, pp 139-158) **PWCs and drift chambers at ISABELLE.** Okuno, H.; Teramoto, Y.; Wheeler, C.D. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

At the 1977 Workshop, attempts were made to predict the behavior of proportional wire chambers at the high particle flux expected at ISABELLE. It was found that chambers running at the now widely used high gas gain would have impaired performance with regard to lifetime, efficiency, stability of gas gain, and position resolution. More information has since become available, and therefore the predictions about these properties are revised in the present study. Improvement can also be expected with much lower gas gain, a possibility that is investigated here in more detail with regard to its effect on position resolution and time resolution. The expected high multiplicity of tracks from a single event, the high event rates, and the requirement for low gas gain necessitate revision of the methods for measuring the second coordinate. Particle identification via measurement of the relativistic rise of energy loss in the chambers has been investigated in more detail than previously, with new data and calculations.

50496 (BNL—50885, pp 159-165) **Appendix D-I: comparison of techniques as applied to specific experiments.** Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

For a specific example of an experiment requiring particle identification, for which various techniques can be compared, several general proposals are considered for the wide-angle hall spectrometer and the narrow-angle hall spectrometer; and finally the possibility of using Cerenkov counters to measure muon momenta in a Z^0 search is discussed.

50497 (BNL—50885, pp 171-175) **Experimental areas: summary of activity.** Pope, B.G. (Princeton Univ., Princeton, NJ); Stevens, A.J. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Participants were divided into two subgroups: a group to examine the large magnetic facilities and their impact on the design of the so-called facility halls, and a nonfacilities group that studied each of the other interaction regions. This latter group considered, in a time-ordered sequence dictated by the proposed construction schedule, topics associated with the wide-angle hall, open areas, and the small-angle hall.

50498 (BNL—50885, pp 177-179) **Efficient extraction of the ISABELLE high energy beam by rebunching.** Myers, S. (European Organization for Nuclear Research, Geneva, Switzerland). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The total stored energy in a single ISABELLE beam is ~ 40 MJ. Each beam will of necessity be dumped at the end of each run. For reasons of beam dynamics it is preferable, during the long physics runs, to operate with unbunched (coasting) beams. It is impossible (by using the normal techniques of fast kicker plus septum magnets) to extract a coasting beam with perfect efficiency. The particles that are not extracted circulate around the machine to be lost in an uncontrolled way (on the septum plate and possibly in the interaction regions). Beam dumping has already been identified as a source of radiation in some experimental areas at the ISR, where the total beam energy is much less (~ 3 MJ). The problem of beam dumping in ISABELLE is further accentuated by the need to protect the superconducting magnets from uncontrolled losses resulting from the dumping process. Two schemes are proposed. Both schemes involve rebunching of a part of the coasting stack and displacing (by acceleration or deceleration) this rebunched beam into the aperture of a partial-aperture horizontal fast-kicker magnet (e.g., an uprated version of the injection kicker). In one scheme the absorber block must be capable of absorbing a large porportion of the stored beam energy, whereas in the other scheme the beam is dumped in segments. In both cases the rising edge of the fast kicker can be arranged to occur during one of the empty spaces between the bunches, thereby eliminating losses on the septum plate and other regions around the machine.

50499 (BNL—50885, pp 180-182) **Problems of operating ISABELLE at largely asymmetric energies.** Myers, S. (European Organization for Nuclear Research, Geneva, Switzerland). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Operation of the ISABELLE rings at asymmetric energies may be required for two independent reasons: (1) physics data taking; (2) operational requirements, e.g., if one of the two beams is lost at 400 GeV, then it can be renewed only by stacking at 29.4 GeV and accelerating from 29.4 to 400 GeV. The operational requirements associated with hardware faults or beam losses can be met also by dumping the second beam and restacking and reaccelerating both beams, but this greatly reduces overall machine utilization. At least two significant problems are associated with operating ISABELLE an unequal energies: (1) the problem of magnetic elements that are common to both beams, e.g., a large dipole spectrometer; (2) the pulsed beam—beam problem known as overlap knockout.

50500 (BNL—50885, pp 183-185) **Beam dumping at ISABELLE.** Myers, S. (European Organization for Nuclear Research, Geneva, Switzerland); Carroll, A.; Stevens, A. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Safely ejecting the ~ 40 MJ stored energy per beam at ISABELLE is clearly a major problem, both for experimental apparatus and for superconducting magnets. Intensive study of this problem, primarily being done by H. Foelsche and J. Claus, is just beginning. A brief review of the current status is given.

50501 (BNL—50885, pp 186-189) **Shielding in experimental areas.** Stevens, A. (Brookhaven National Lab., Upton, NY); Tarnopolsky, G.; Thorndike, A.; White, S. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The amount of shielding necessary to protect experimental detectors from various sources of background radiation is discussed. As illustrated an experiment has line of sight to sources extending ~ 90 m upstream from the intersection point. Packing a significant fraction of this space with shielding blocks would in general be unacceptable because primary access to the ring tunnel is from the experimental halls. (1) From basic machine design considerations and the inherent necessity to protect superconducting magnets it is expected that experimental areas in general will be cleaner than at any existing accelerator. (2) Even so, it will likely be necessary to have some shielding blocks available to protect experimental apparatus, and it may well be necessary to have a large amount of shielding available in the WAH. (3) Scraping will likely have some influence on all halls, and retractable apparatus may sometimes be necessary. (4) If access to any tunnel is needed to replace a magnet, one has 96 h (4 days) available to move shielding away to permit access without additional downtime. This (the amount of shielding one can shuffle about in 96 h) is a reasonable upper limit to shielding necessary in a hall (or adjacent tunnel).

50502 (BNL—50885, pp 192-200) **Experimental use of neutrinos from ISABELLE beam dumps.** Bozoki, G.E. (Brookhaven National Lab., Upton, NY); Thorndike, A.M.; Mann, A.K. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The purpose of this paper is to emphasize the technical feasibility and possible applicability of using ISABELLE beam dumps as powerful sources for directed high energy neutrino bursts. In the present machine design two dump systems are applied to

absorb the extracted fast beams. These systems are normally activated when a machine working period terminates or when the beams in the rings become somewhat anomalous. Disregarding the latter, emergency extractions, the expected normal beam extraction rate is 1 to 2 per day, when about (6.3 to 7.5) x 10^{14} protons are hitting the external targets during a pulse length of 50 μsec. These protons are considered so far to be useless. The present interest in having neutrino beams at high energy and measurable intensity at very large (so to say, global) distances, however, suggests a natural application of these apparently useless protons: converting them into neutrinos. In other words, the proton dumps can serve as neutrino bursters. This does not mean that the ISABELLE neutrino bursters would compete with the dedicated neutrino beams of various laboratories such as FNAL. However, since they would provide 2 to 4 neutrino bursts per day during the whole lifetime of the machine (without disturbing the ISABELLE normal research program), these neutrino bursts might have importance for research activities that require years of continuous running of massive neutrino detectors. It is anticipated that among these activities the following would be included: (1) the study of coherent neutrino regeneration, (2) calibration and permanent testing of cosmic-ray and astrophysical neutrino detectors, (3) research on the practical applicability of neutrinos in telecommunication, and (4) certain astro- and geophysical applications.

50503 (BNL—50885, pp 205-207) **Crafty cranes, or the feasibility of robots at ISABELLE.** Carroll, A.S. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

As currently envisioned, ISABELLE will have to be shut down at regular intervals much shorter than the natural lifetime of the beams in order to allow the experiments into the six experimental halls to make simple repairs or simple modifications to their apparatus. Much of this downtime and frustration could be avoided if there were a class of radiation workers who could withstand ~ 10^5 rads. Obviously such a class of workers would be robots.

50504 (BNL—50885, pp 214-218) **Mass resolution for lepton pairs at ISABELLE.** Baltay, C. (Columbia Univ., New York, NY); Paige, F.E. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Experiments measuring e^+e^- and $\mu^+\mu^-$ pairs will be the principal way of searching at ISABELLE for the Z^0 and for vector mesons made from new heavy quark-antiquark (Q anti Q) pairs. Although the best possible mass resolution is clearly of benefit in such experiments, excessive resolution would lead to an unnecessarily large detector. It is believed that a mass resolution of a few percent is appropriate in searching both for the Z^0 and for new Q anti Q states. However, there are some interesting experiments which would require much better mass resolution, of order 1/4% FWHM.

50505 (BNL—50885, pp 235-238) **Comments on two o'clock experimental area (small-angle hall).** Aronson, S. (Brookhaven National Lab., Upton, NY); Brody, H.; Joestlein, H.; McCarthy, R.; Lanou, R.E.; Read, A.L.; Yodh, G.B. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The principal findings are (1) that a simpler model for hall, hardstand, access, shielding, and trenches is possible which will accommodate all the experiments, and (2) that a stub should be included in the initial construction.

50506 (BNL—50885, pp 239-241) **Solenoid spectrometer magnets.** Baltay, C. (Columbia Univ., New York, NY); Danby, G.; Mishina, M.; Wanderer, P.; Willis, W.;. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

This committee considered three solenoid detectors that were described during the Summer Study and could be thought of as candidates for ISABELLE detectors. They are roughly characterized by their diameters: 3, 5, and 8 m. The committee then attempted to estimate the required size of an experimental hall considering likely physics goals, detector and return yoke geometries, thickness of superconducting coils, necessary space for detector repair, etc. This exercise then allows the sizes of the detectors to be compared with the sizes of the large facility halls in the ISABELLE proposal.

50507 (BNL—50885, pp 249-266) **General features of some possible large spectrometer magnets for use at ISABELLE.** Taylor, T.M. (European Organization for Nuclear Research, Geneva, Switzerland). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

It appears that the size of many of the proposed detectors for ISABELLE will be such that magnets will generally have to be used by a series of teams who may wish to perform a variety of experiments. It therefore seems desirable that, where possible, the magnets should be designed to have a field distribution and form satisfying the needs of several different experimental arrangements. This leads to the concept of the magnet facility. The purpose of this note is to describe how such magnet facilities for ISABELLE might look and to highlight the advantages and limitations of the different configurations.

50508 (BNL—50885, pp 267-273) **Applications of superconducting technology to ISABELLE detectors.** Allinger, J.E.; Danby, G.T.; Jackson, J.W.; Prodell, A.G. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The three familiar types of magnetic-field arrangements - polar, solenoidal, and toroidal - have their advantages and disadvantages, both intrinsically for particle resolution in detectors and also from the point of view of their various technological requirements. Iron is a wonderful magnetic material apart from being limited by its saturation induction of 1.5 to 2.0 T in return yokes. Its cost per unit weight in fabricated magnets is small compared with that of other parts of the systems. Nevertheless, for the very large magnetic detectors under consideration, it will dominate costs for conventional iron-determined magnetic circuits because magnet volume and weight grow more rapidly than magnetic rigidity with increasing dimensions. In principle, the iron in a magnet yoke can be replaced by current sheets on its surface. Thus, a circular-poled iron dipole is equivalent to the fringing field in a gap left between two series-aiding solenoidal coils. Similarly, the dipole can be considered as a gap in an otherwise continuously wound toroid. This simple visualization serves to illustrate some of the contrasting features of each topology.

50509 (BNL—50885, pp 278-294) **Feasibility of studying large p/sub perpendicular to/ in ISABELLE's wide-angle hall.** Aronson, S. (Brookhaven National Lab., Upton, NY); Danby, G.; Engelmann, R.; Foley, K.; McCarthy, R.; Paige, F.; Pope, B.; Thorndike, A. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The experimental area at 6 o'clock in the present ISABELLE site plan has a configuration suitable for studying particles produced at large angles relative to the beam lines. It is natural to think of housing a program of large p/perpendicular to/ studies in this area. A particular device has been considered, namely a pair of multiparticle spectrometers back-to-back at 90° to the beams, as a vehicle for carrying out this program. Enough details are presented to allow for a reasonable test of the planned 6 o'clock area as a site for such experiments. In summer, this study shows that a rather ambitious program of experiments can be performed in this area with some relatively easily implemented changes in the hall design.

50510 (BNL—50885, pp 303-316) **Feasibility study of experiments to measure inclusive reactions at large x/sub F/ in ISABELLE's small-angle hall.** Aronson, S. (Brookhaven National Lab., Upton, NY); Danby, G.; Foley, K.; Paige, F.; Thorndike, A.; Engelmann, R.; McCarthy, R.; Pope, B. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

As a way of testing current ideas on the construction of experimental halls at ISABELLE, a particular class of experiments suggested for the small-angle (or 2 o'clock) hall are examined: $p + p \rightarrow p + X$, and $p + p \rightarrow c + X$, c is not = p. Somewhat more detail has been incorporated than in previous summer study and summer workshop treatments of these experiments. Briefly, the result of this examination is that inclusive single-particle experiments are feasible over a suitable kinematic range without the use of previously proposed special insertion quadrupoles. The forward single-arm spectrometer is housed in a separate tunnel of modest transverse dimension. The extraction of scattered particles ($\theta > \sim 1$ mrad) into the spectrometer is accomplished with Lambertson septa and current sheet septa. Provision is made for overlap with the kinematic region covered by ISR and Fermilab experiments. Section II is a review of the physics objectives of such experiments. Section III describes the general layout of the apparatus, with the extraction system and the spectrometer discussed in more detail in Sections IV and V respectively. A guess at how this experiment would fit into the overall small-angle physics program is presented in Section VI.

50511 (BNL—50885, pp 319-323) **Summary of data-handling subgroup.** Zeller, M.E. (Yale Univ., New Haven, CT). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

In an effort to obtain better quantitative estimates of computing and data-handling needs at ISABELLE, the data-handling group examined such needs for a few experimental devices that seem to be fairly well defined at this time. While it was understood that the choice of devices may not be a realistic sampling of what will be the actual configuration, the spectrum of needs was quite broad and certain "universal principles" were determined whereas other pre-

conceived notions were brought into doubt. The five devices under study were (1) small-angle detectors, (2) lepton detector, (3) wide-angle detector, (4) axial-field spectrometer (AFS), and (5) large-aperture dipole spectrometer (LAD), listed in order of increasing complexity and magnitude of data-handling needs.

50512 (BNL—50885, pp 324-330) **Data handling in the large-aperture dipole spectrometer.** Russ, J.S. (Carnegie-Mellon Univ., Pittsburgh, PA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

This survey of data-handling problems in the large-aperture dipole spectrometer focusses on the questions of viability of data collection systems in the presence of high rates and on the scale and nature of track processing devices. LAD requirements do not seem to be well served by a pure software analysis scheme, even with a full 7600 as the LICS. Successful implementation of a device of this scope seems to require hardware track processing with a speed at least 10 times as fast as that of a 7600. Thus, the problems are tractable but nonetheless formidable. The physics power of such a device depends heavily on triggering schemes and on the physics need to reconstruct whole events of the complications expected at ISA energies. The conclusion here is that if someone can show the physics justification for LAD, then, given a major effort in hardware track processing, the output can be handled in a decent fraction of the lifetime of a physicist (or 100 physicists). The characteristics of the LAD are summarized.

50513 (BNL—50885, pp 331-336) **Data handling for the axial-field spectrometer.** Beier, E. (Univ. of Pennsylvania, Philadelphia, PA); Killian, T.; Lesnik, A.;. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The axial-field spectrometer (AFS) data-handling subgroup undertook a study of the data acquisition and data processing problems associated with a particular large ($\sim 4\pi$ steradian) detector. This study is intended to supplement and extend the conclusions reached at the ISABELLE 1977 summer workshop.

50514 (BNL—50885, pp 337-356) **Data handling for the wide-angle hall jet experiment.** Cassel, D. (Cornell Univ., Ithaca, NY); Engelmann, R.; Gordon, H.; Grannis, P.; Mallik, U.; Meadows, B.; Morris, T.; Plano, R.; Saulys, A.; Stein, S. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The subcommittee on data handling for the two-arm spectrometer in the wide-angle hall has based its study on the draft report by Aronson et al. It has attempted to produce a design of the several layers of triggering and a schematic data acquisition system; discussed the configuration of the local intersection computer system (LICS); and estimated the time required to analyze a typical event. The inclusive production of jets at 90°, with the aim of measuring the production cross section for these jets and the distributions of their constituents is discussed.

50515 (BNL—50885, pp 357-366) **Data handling for the lepton detector.** Cutts, D. (Brown Univ., Providence, RI); Droege, T.F.; Kasha, H.; Kirsch, L.E.; Littenberg, L.; Matthews, J.A.J.; Rabin, M.S.Z.; Scharenguivel, J. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The lepton detector group was charged with evaluating the data acquisition and processing needs of a "typical" lepton-oriented large-solid-angle detector. Motivated by recent developments from several groups, a configuration of the data readout systems (including microprocessors), the control computer(s), and the local intersection computer substantially different from that in previous ISABELLE studies was suggested.

50516 (BNL—50885, pp 367-370) **Data handling for small-angle experiments.** Gibbard, B. (Cornell Univ., Ithaca, NY); Zeller, M. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

In estimating the data-handling requirements for small-angle detecto~s the apparatus described by Aronson et al. was considered first. T iis detector consists of a single forward arm spectrometer running approximately tangent to the main rings in a stub $\sim$ 100 m long. Its function is to examine the distributions of fast forward particles in the reactions $pp \rightarrow pX$ and $pp \rightarrow cX$, c is not = p. The detector elements consist of four drift chambers with <2000 wires, trigger counters, two Cerenkov counters, and a transition radiation detector (TRD). The rates in these elements are also quite modest, with beam—beam interactions into the spectrometer acceptance being <5 kHz at $L = 10^{33}$. It is estimated that beam-gas rates will be <10% of beam—beam rates, and that the multihit frequency from a single event is 10%. Thus, as opposed to 4π detectors, this system obviously has minimal data acquisition requirements. One unique property of the method of data acquisition for the experiment is the large number of individual runs for different spectrometer settings that will be necessary. The range of rates is from 0.1 to 20/sec for these runs with $\sim$ 200 runs. Thus the spectrometer must be instrumented for rapid changes of magnet currents and positions, changes in Cerenkov counter pressures, and timing changes in the detector. This requirement, like that for data handling, can be satisfied by techniques already in common use.

50517 (BNL—50885, pp 371-380) **Hardware architecture for processing detector data in real time.** Benenson, G.; Knapp, B.; Sippach, W. (Columbia Univ., New York, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

When a general-purpose computer is used to process data from a large-scale detector, the generality of the computer is important for specifying the processing algorithms. However, the need to fetch and execute centrally stored instructions, one at a time, makes the generality of the computer burdensome as more and more data are processed. A way of structuring algorithms with hardware so that data can be processed on a time scale consistent with a high trigger rate is described.

50518 (BNL—50885, pp 381-384) **Notes on the fast bus system.** Leipuner, L. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The Advanced Systems Design Group was formed to specify and design a system for a new standard for data acquisition in high-energy physics. The design work is reasonably far along; an abbreviated progress report is presented here. In any system there will be modules that gather and process data from the experiment's detectors and perhaps from other sources such as the accelerator control system or monitoring system. In order to have a general system these modules must be able to communicate with each other and perhaps with a host computer or a group of controlling computers. A very general communications system is the bus system, used in computers, in which all devices are connected in parallel to a group of lines, typically 50 to 100. By means of a protocol of communication on some of these lines, a device that wants to control the bus makes its wishes known. If the device is the highest priority one currently asking for the bus, it gains bus mastership and then signals another device that it wants to communicate with by means of a set of address lines. This system works very well in a computer that includes a processor, memory, and peripheral devices; its disadvantages are that only one device can be bus master at a time and only one communication can take place at a time. The proposed solution to this problem is to segment the bus so that each segment can operate independently without interfering with another one. This allows a large amount of parallel operation. It is necessary for one segment to communicate with other ones at some point in the process, and this is achieved by a device called the segment interconnect (SI).Much of the character of the system will be determined by the details of the SI. One possibility is a device that passes information only when the address falls within a band of values (or perhaps several bands); details of its specification are being worked on now.

50519 (BNL—50885, pp 385-392) **Large mass storage facility.** Peskin, A.M. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

In May 1978 the Chairman of the LNL Applied Mathematics Department organized a group to study the questions surrounding the proposed acquisition of a large mass storage device for the Laboratory's central science computing facility (CSCF). This action was based on some optimistic forecasts for funding of such a procurement in the near future. The study group was to perform several functions: (1) confirm the programmatic justification for this device, (2) survey the spectrum of current and future vendor products that may meet the need, (3) draft a set of specifications for the system, (4) discuss possible alternatives to alleviate the problem in the event that procurement is delayed or denied because of budgetary limitations. This paper is the final report of the group.

50520 (BNL—50885, pp 395-398) **Central detector for jets and W's (JAWS).** Joestlein, H. (State Univ. New York, Stony Brook). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

As an exercise in determining what type of detector might occupy the central region of either the hadron facility (WASP and FATS) or the high p/sub t/ double-arm spectrometer in the wide-angle hall (WAS), a suitable detector which has the following capabilities and/or components (from the intersection point out) is considered: (1) Magnetic analysis and tracking in a 1.5-m-radius, 4-Tesla solenoid, concentric around the beam, equipped with a high-pressure jet chamber system having excellent momentum resolution and potential for dE/dx particle identification. Whether this works will be known as soon as the JADE detector starts taking data at PETRA. (2) An electromagnetic shower calorimeter (Fe/acrylic

scintillator), 12 radiation lengths outside the coil cryostat, with a twofold purpose: to allow measurement of neutral pions, and to improve the resolution of the hadron calorimeter by separating the em and hadronic components. (3) A hadron calorimeter (Fe/acrylic scintillator) of 5 absorption lengths. (4) Probably an outer "skin" of muon detectors, e.g., the extruded aluminum drift-chamber type proposed for the CERN anti pp detector UA1.

50521 (BNL—50885, pp 401-405) **Ambiguities in drift chambers due to high event rates.** Kanofsky, A. (Lehigh Univ., Bethlehem, PA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The fraction of the cells of a cylindrical drift chamber in which one would obtain the incorrect arrival time of a track because of following events is considered. Also, following events could result in the incorrect value for charge collected on the wires, which would then give incorrect dE/dx and charge division values. First, the probability for an event to be followed by 1, 2, and higher numbers of events during the sensitive time of the chamber is considered. Then, taking this probability, the probability of these events giving multiple hits in the single cells is determined

50522 (BNL—50885, pp 406-410) **Channeling revisited.** Kanofsky, A. (Lehigh Univ., Bethlehem, PA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Possible uses of channeling at ISABELLE have been reported. Channeling is the phenomenon of coherent scattering of particles between the lattice planes in a crystal. Such a process is shown schematically but actually thousands of atoms are usually needed to bend a particle trajectory. The uses of channeling discussed include an internal beam profile device and an effective low density targeting device. The behavior exploited in these applications is that the particle, once within the channel (moving along the crystal principal axis), continues unscattered through the channel. That is, the crystal acts as if it were transparent to the particle, and in fact dE/dx losses are about half what they are for random orientation of path to crystal. Since the previous report appeared, an experiment has been done on channeling at FNAL with particles having energies of 35, 100, and 250 GeV. Pronounced channeling is seen at all energies with no evidence of particle scattering in the 2-cm-thick Ge crystal used, even at the lowest energy. Since the dechanneling length (average path length before a particle is scattered out of the channel) is theoretically proportional to the energy, one would expect that, if the dechanneling is >2 cm at 35 GeV, it should be >20 cm at the 400-GeV energies of ISABELLE. This experiment also produced other interesting results.

50523 (BNL—50885, pp 411-416) **Spectrometer jet acceptance.** Kanofsky, A. (Lehigh Univ., Bethlehem, PA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

One of the first experiments to be performed at ISABELLE will be a search for jet production at high p/sub t/. Jets are clusters of particles that are thought to result from fragmentation of the quarks originally produced in quark—quark collisions resulting from proton—proton collisions. Of special interest will be experiments to measure jet—jet correlations and thus to determine internal structure form factors, parton and gluon jet distributions, fragmentation functions, etc. Whether the proposed apparatus is adequate for measuring such correlations is considered. The WASP spectrometer described in 1976 and the wide-angle spectrometer described in 1975 are taken as typical.

50524 (BNL—50885, pp 417-421) **Use of streamer chambers at ISABELLE.** Kanofsky, A. (Lehigh Univ., Bethlehem, PA). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

M. Chen has proposed that an effective way to search for the W would be with a streamer chamber, because of the superior momentum resolution that may be achieved. Some other useful applications of streamer chambers are considered in view of experience with them in cosmic ray, particle identification, and particle-nuclei interaction experiments. Areas where they may be useful, and some of their problems and limitations are discussed. Some potential applications include the detection and measurement of (1) heavy particle production, (2) multiply charged particles, and (3) the relativistic rise. Each of these is discussed.

50525 (BNL—50885, pp 422-437) **Conceptual design of a solenoidal magnet detector.** Kondo, A. (Tsukuba Univ., Sakura, Ibaraki, Japan); Maki, A.; Mishina, M.; Takasaki, F. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

A conceptual design of a large-aperture solenoidal magnet detector is presented with primary emphasis on large p/sub t/ phenomena. The physics goals of this detector are, as in many other proposals, to detect weak bosons W/sup +-/ and Z^0, high mass flavors, heavy leptons, Higgs particles, and high p/sub t/ jets, and to check QCD, etc. A solenoidal configuration was chosen rather than a dipole or a toroidal one because with a quite uniform axial field, (1) it will be quite easy to make a fast high p/sub t/ trigger, (2) data analysis will be much simpler, (3) coupling to the beam is minimal, and (4) the detector has a large p/sub t/ coverage.

50526 (BNL—50885, pp 442-445) **Measurement of diffractive dissociation at ISABELLE.** Zeller, M.E. (Yale Univ., New Haven, CT). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Diffractive dissociation will be an important class of reactions in studying hadron interaction dynamics at high energies. Present ideas relate inelastic channels to elastic scattering and total cross sections via exchange of the pomeron, and also to gluon inelastic scattering. The cross section for these processes is estimated to be about 5 mb and thus they represent the largest single contribution to the total cross section after elastic scattering. A better understanding of the dynamics leading to rising total cross sections and the shape of the elastic differential cross section can be obtained with measurements of $d^2\sigma/dtdM$ for other diffractive processes. Motivated by a need to obtain quantitative estimates of data-handling requirements for the elastic scattering detector, we have designed an apparatus to measure the cross sections for $pp \rightarrow (n\pi^+)p$ for small $(n\pi^+)$ invariant masses.

50527 (BNL—50885, pp 274-277) **Simple, inexpensive dipole spectrometer for ISABELLE.** Siegel, R.T. (College of William and Mary, Williamsburg, VA); Leipuner, L.B.; Larsen, R.C.; Adair, R.K.; Kasha, H. Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

The magnets from obsolete large cyclotrons have been found to be extremely useful as spectrometer magnets at high energy physics laboratories. The Chicago cyclotron magnet is the basis of a large spectrometer at Fermilab, where very interesting measurements of muon production and interactions have been conducted. Fermilab is now considering the acquisition of the Nevis cyclotron magnet as the basis of another di-muon and hadron spectrometer. The magnet from the Carnegie Institute of Technology cyclotron has been transported to CERN where it is to be used as a spectrometer magnet at the ISR. A proposal to acquire the Space Radiation Effects Laboratory (SREL) 5-m cyclotron magnet for use as the basis of a large, simple dipole spectrometer at an ISABELLE colliding-beam intersection is presented.

50528 **Loss-free method of charging accumulator rings.** Maschke, A.W. (to Dept. of Energy). US Patent Application 916,182. 16 Jun 1978. 10p.

A method for the production of high current pulses of heavy ions having an atomic weight greater than 100 is disclosed. A linear accelerator-based apparatus for carrying out the method is also described. Pulses formed by the method are suitable for storage in a storage ring. The accumulated pulses may be used in inertial fusion apparatus. 2 figures.

INSTRUMENTATION

RADIATION INSTRUMENTATION

REFER ALSO TO CITATION(S) 49575

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 49587

50529 (CONF-790590—1) **Nuclear criticality evacuation with telemonitoring and microprocessors.** Fergus, R.W.; Moe, H.J. Sr. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 11p. P 02/MF A01.

From Aerospace/test measurement symposium; Canoga Park, CA, USA (6 May 1979).

At Argonne National Laboratory, criticality alarms are required at widely separated locations to evacuate personnel in case of accident while emergency teams or maintenance personnel respond from a central location. The system functions have been divided in a similar manner. The alarm site hardware can independently detect a criticality and sound the evacuation signal while general monitoring and routine tests are handled by a communication link to a central monitoring station. The radiation detectors and evacuation sounders at each site are interconnected by a common two conductor cable in a unique telemonitoring format. This format allows both control and

data information to be received or transmitted at any point on the cable which can be up to 3000 meters total length. The site microprocessor maintains a current data table, detects several faults, drives a printer, and communicates with the central telemonitoring station. The radiation detectors are made with plastic scintillators and photomultiplier tubes operated in a constant current mode with a 4 decade measurement range. The detectors also respond within microseconds to the criticality radiation burst. These characteristics can be tested with an internal light emitting diode either completely with a manual procedure or routinely with a system test initiated by the central monitoring station. Although the system was developed for a criticality alarm which requires reliable and redundant features, the basic techniques are useable for other monitoring and instrumentation applications.

50530 (LA—7408-C) **Industrial workshop on LASL semiconductor radiation-detector research and development.** Endebrock, M. (comp.). (Los Alamos Scientific Lab., NM (USA)). Nov 1978. Contract W-7405-ENG-36. 35p. (CONF-7705176—). P 03/MF A01.

From Industrial workshop on LASL semiconductor radiation detector research and development; Los Alamos, NM, USA (19 May 1977).

An Industrial Workshop on LASL Semiconductor Radiation Detector Research and Development was held at the Los Alamos Scientific Laboratory (LASL) in the spring of 1977. The purpose was to initiate communication between our detector research and development program and industry. LASL research programs were discussed with special emphasis on detector problems. Industrial needs and capabilities in detector research and development were also presented. Questions of technology transfer were addressed. The notes presented here are meant to be informal, as were the presentations.

50531 (LA—7890-C) **ANL—LASL workshop on advanced neutron detection systems.** Kitchens, T.A. (comp). (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 18p. P 02/MF A01.

A two-day workshop on advanced neutron detectors and associated electronics was held in Los Alamos on April 5—6, 1979, as a part of the Argonne National Laboratory—Los Alamos Scientific Laboratory Coordination on neutron scattering instrumentation. This report contains an account of the information presented and conclusions drawn at the workshop.

50532 **Battery operated portable phoswich detector for field monitoring of low levels of transuranic contaminants.** Umbarger, C.J.; Wolf, M.A. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **155**: No. 3, 453-357(1 Oct 1978).

A fully portable, phoswich-detector-based, radiation survey instrument has been developed. The design takes advantage of the low photon background characteristics of a phoswich scintillator system to detect small amounts of low energy photon emitters such as plutonium and americium. For the portable and unshielded instrument a background reduction of approximately 3 compared to an equivalent thin NaI detector is achieved with little loss of sensitivity. With shielding, the background reduction is approximately 6 compared to an equivalent thin NaI detector.

50533 **Ion detecting and measuring system with wide dynamic range.** Stoffels, J.J.; Lagergren, C.R.; Hof, P.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). *Int. J. Mass Spectrom. Ion Phys.;* **28**: No. 2, 159-169(Oct 1978).

An ion detecting and measuring system is described which has a dynamic range in ion current measuring capability of ten decades. The detector is basically a Daly ion-electron-scintillation converter. In its normal pulse-counting mode of operation, it is usable for ion currents between 10^{-20} A and about 10^{-13} A with the upper limit determined by dead-time losses in the counting system. Two different modification schemes have been devised which extend the dynamic range to about 10^{-10} A of ion current. One of the schemes is especially useful for fast, transient signals such as are encountered in direct-inlet mass spectrometry of airborne particles. A device to integrate such fast, transient ion signals over the dynamic range of the detector is also described.

50534 **Resonant ionization studies of the fluctuation of proportional counters.** Hurst, G.S.; Allman, S.L.; Payne, M.G.; Marshall, K.A.; Soohoo, K.L. (Oak Ridge National Lab., TN (USA)). *Nucl. Instrum. Methods;* **155**: No. 1, 203-209(15 Sep 1978).

.. new technique is reported for the study of gas amplification fluctuation in proportional counters. Use was made of pulsed laser beams to carry out two-step resonant ionization spectroscopy (RIS) of Cs atoms which were seeded at very low concentration into the counting gas. With this independent determination of the fluctuation of the gas amplification, one can determine the Fano factor which enters into the statistics of the ionization of gases by swift charged particles. Accordingly, RIS measurements were made in P-10 gas (90% Ar+10%CH_4), and the fluctuations in pulse heights were compared with fluctuations observed with X-ray sources to obtain Fano factors. The authors found, for photoelectrons at 2.6 keV and at 5.9 keV stopping in the counting gas, the Fano factors 0.31+-0.10 and 0.21+-0.10, respectively.

50535 **Absolute neutron flux measurements using an NE-110 scintillation counter.** Renner, C.; Hill, N.W.; Morgan, G.L.; Rush, K.; Harvey, J.A. (Oak Ridge National Lab., TN (USA)). *Nucl. Instrum. Methods;* **154**: No. 3, 525-533(1 Sep 1978).

A neutron detector consisting of an NE-110 plastic scintillator has been calibrated for absolute neutron fluence measurements in the energy range 80 to 500 keV. Efficiencies were determined by Monte Carlo calculations. Comparisons of measured and calculated pulse height spectra are presented.

50536 **Instrument for monitoring the transuranic content of chopped leached hulls from spent nuclear fuel elements.** Wogman, N.A.; Brodzinski, R.L.; Brown, D.P. (Battelle, Northwest Lab, Richland, Wash). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 284-288(May 1978). (CONF-780522—).

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

This communication describes a neutron detection system for the direct measurement of the transuranic elements in the hulls of chopped leached fuel elements and some associated effluent wastes. The monitor detects neutrons arising from spontaneous fission and from (alpha,n) reactions on oxygen in the hulls and wastes. The system is constructed using a massive external neutron shield, an internal lead gamma-ray shield between the sample and the neutron detectors, and an electronic system which records all single and coincidence neutron events which occur during a preset time interval. Both the transuranic neutron flux and the cosmic-ray produced neutron background are determined simultaneously. The estimated detection limit of the system is 2 mg of Pu in a 10sup 4 second counting period.

RADIATION DOSEMETERS

50537 (LA-UR—79-1504) **Multichannel electrometer data-acquisition system.** Somers, J.; Hogstrom, K.R.; Slice, R.T.; Rosen, I.I.; Smith, A.R. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790549—14). P 02/MF A01.

From Conference on computerized data - acquisition systems in particle and nuclear physics; Santa Fe, NM, USA (14 May 1979).

A multichannel electrometer data-acquisition system, with associated software control, has been developed for dosimetry measurements of the pion beam at the Clinton P. Anderson Meson Physics Facility in Los Alamos, New Mexico. This system increases dosimetry data-acquisition rates by a factor equal to the number of data channels in use. It is based on a newly-developed electrometer amplifier capable of accurate measurements at picoampere signal levels. Design and construction of the electrometers is presented here in detail, and examples of data acquired with this system are presented. The effect on the readings due to scattered and background radiation has been measured.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

50538 **Reevaluation of precise γ-ray energies for calibration of Ge(Li) spectrometers.** Helmer, R.G.; Greenwood, R.C.; Gehrke, R.J. (Idaho National Engineering Lab., Idaho Falls (USA)). *Nucl. Instrum. Methods;* **155**: No. 1, 189-201(15 Sep 1978).

A set of previously published γ-ray energies, from 45 to 1300 keV, that are useful for calibration of Ge(Li) spectrometers has been reevaluated to be consistent with both a new reference value for the γ-ray energy scale and the 1973 least-squares adjustment of the fundamental constants. This new energy scale is based on a recent measurement at the National Bureau of Standards of the absolute γ-ray wavelength for the 411-keV line from ^{198}Au. This wavelength corresponds to an energy of (411.804 41 +- 0.001 08) keV. In updating the previous set of γ-ray energies, data from several more recent and very precise measurements with curved-crystal diffraction spectrometers have been included and a number of older and less precise measurements have been dropped. With one exception, the new set of energies is completely based on 411-^{198} Au as the reference line and excludes the X-ray based energies previously used. At approximately 1 MeV the proposed energies typically have measurement uncertainties of 4 eV and an energy scale error of 3 eV compared to 14 eV and 17eV in a previous publication.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 50467, 50468, 50469, 50470, 50471, 50472, 50474, 50488, 50489, 50490, 50491, 50493, 50494, 50495, 50506, 50521, 50649

50539 (BNL—50885, pp 166-167) **Appendix D-II: status of microchannel plate photomultiplier tubes.** Dhawan, S. (Yale Univ., New Haven, CT). Katowice, 1-5 Oct 1978.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Development work on microchannel plate photomultiplier tubes is briefly reviewed. Investment is still required to investigate: improved lifetime of cathode and MCP; segmented anodes; single-anode tubes with low cost, high gain, and long life; alternative methods of readout; and fast readouts. (GHT)

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 50555, 50582

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

50540 Radiation effects in 1.06-μm InGaAs LED's and Si photodiodes. Barnes, C.E. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **50**: No. 8, 5242-5250(Aug 1979).

Because of the low-intrinsic and radiation-induced attenuation losses in glass fibers in the wavelength range 1.0—1.3 μm, emitters and detectors operating in this range are of practical importance for radiation-environment applications. We have studied the effects of both γ and neutron irradiation on the properties of InGaAs LED's emitting at 1.06 μm and Si photodiode detectors optimized for this wavelength. While the preirradiation light output of the InGaAs LED's is low relative to many GaAs LED's, the InGaAs devices exhibit less sensitivity to radiation than the most radiation-hardened GaAs LED's. No significant neutron-induced light-output degradation is observed below 1×10^{13} n/cm², while 2×10^{7} Co-60 rads are required before any γ-induced degradation is observed. In addition, a significant portion of the γ-induced light-output degradation can be recovered by applying forward-bias currents of the order of 50 mA in magnitude. Although γ irradiation up to 2×10^{8} rads has essentially no effect on the photodiodes, neutron fluences above 2×10^{14} n/cm² cause a reduction in responsivity. Analysis of the neutron-induced increases in the photodiode leakage current with the guard ring attached reveals a lifetime-damage constant product of 4×10^{-12} cm²/n. Laboratory isolators made up of these emitters and detectors have typical preirradiation current-transfer ratios of 5×10^{-4} which decrease by a factor of 10 after an irradiation of 1.5×10^{14} n/cm².

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 49447, 49471, 50482

50541 (EPRI-NP—1107) **Semiautomatic weld crown contouring equipment. Final report.** (Sigma Research, Inc., Richland, WA (USA)). Jun 1979. 64p. P 04/MF A01.

Pipe welds in nuclear plants are presently finished by tedious hand grinding for ultrasonic testing. A study has now been completed demonstrating that a semiautomatic machine for finishing weld crowns is quite feasible. Such a machine could produce more consistent contours than hand finishing as well as improved surface finishes; also it could virtually eliminate inadvertent undercutting of the weld crown and the need for subsequent repair before testing. The machine could reduce the time required to finish the welds by a factor of 10 on Class-1 welds, saving $31 million for plants being built and $21 million for reactors being planned. To determine feasibility and develop the concept, specialists of 30 utilities were surveyed to establish practical performance requirements for the machine including pipe materials, size of pipes, space restrictions, typical misalignments, offsets and out of roundness. The conceptual design is an external lathe that clamps over and encircles the pipe. The lathe tool bit is driven around the pipe by an electric motor. The radial position of the tool bit is real-time controlled by an on-board microprocessor to produce the smoothest blend across the area of the joint between the two pipes. The microprocessor program is set by making initial circumferential scans on both sides of the weld with an electronic stylus in place of the tool bit. This provides the microprocessor with initial and final coordinates from which to compute the cut. To test the general concept of an external lathe, a test machine was fabricated and set up to remove a 308 stainless steel weld crown on a 10-inch-diameter Schedule 40 pipe. The machine easily finished the welded area producing a surface finish of better than 100microinches RMS in one pass while simultaneously removing a weld crown 0.150 inches thick. Tests of the microprocessor-controlled cutting head and development of a field prototype design are planned.

50542 (LA-UR—79-1251) **Philosophy of a computer-automated counting system.** Perry, D.G.; Giesler, G.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-790549—3). P 02/MF A01.

From Conference on computerized data - acquisition systems in particle and nuclear physics; Santa Fe, NM, USA (14 May 1979).

The LAMPF Nuclear Chemistry computer system is designed to provide both real-time control of data acquisition and facilities for data processing for a large variety of users. It is a PDP-11/34 connected to a parallel CAMAC branch highway as well as a large variety of peripherals. The philosophy for the design of this system is discussed; such points as use of the computer for control only versus direct data acquisition by the computer, why a CAMAC system was chosen, and the advantages and disadvantages of this system are covered. Also discussed are future expansion of the system and what might be done differently if the system were redesigned. 3 figures.

50543 (MLM—2624) **Assessment of a new hydrogen isotope gas chromatograph.** Warner, D.K. (Mound Facility, Miamisburg, OH (USA)). 26 Jul 1979. Contract EY-76-C-04-0053. 10p. P 02/MF A01.

The analytical precision of a gas chromatograph designed to measure hydrogen isotopes and chemical impurities was determined. Error ranged from 0.9% to 3.5% at the 1 sigma level for the eight measured nonradioactive species.

50544 (SAND—78-1836) **QUANT: a quantitative analysis schedule for Tracor Northern automated electron microprobes.** Chambers, W.F.; Doyle, J.H. (Sandia Labs., Albuquerque, NM (USA); Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). Jul 1979. Contract EY-76-C-04-0789. 25p. P 02/MF A01.

QUANT is a special schedule for electron microprobes which are automated with Tracor Northern electronics. QUANT is called from the SANDIA TASK-78 control program and provides simultaneous data acquisition and data reduction capabilities using either a first principles atomic number, absorption, fluorescence (ZAF) technique or a matrix correction (Bence—Albee) technique. During operation, QUANT controls the execution of three auxiliary programs - BA78, ZAF78, and SETUP.

50545 (UCRL—15037) **Pulsed WIP electron gun. Final report: design phase 1 x 70 cm cooled WIP electron gun, 1 December 1978—2 February 1979.** Wakalopulos, G.; Gresko, L. (Hughes Aircraft Co., Culver City, CA (USA)). 1979. Contract W-7405-ENG-48. 41p. P 03/MF A01.

Presented here are design criteria for a full scale (70 cm) WIP electron gun system capable of long run operation with the following specifications: foil area ~ 70 x 1 cm, electron beam current density ~ 1 A/cm², pulse length < 200 ns FWHM, pulse tail < 25f f pulse energy, average current ~ 2 ma/cm², voltage -150 kV, voltage droop < 10%, Rep rate ~ 10 KHz, power ~ 20 kW, run time ~ 30 min, and jitter ~ 10 μs.

50546 (UCRL—52532(Vol.4)(Pt.3)) **Computer automation of continuous-flow analyzers for trace constituents in water. Volume 4. Description of program segments. Part 3. TAASTART.** Crawford, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jan 1979. Contract W-7405-ENG-48. 20p. P 02/MF A01.

This report describes TAASTART, the third program in the series of programs necessary in automating the Technicon AutoAnalyzer. Included is a flow chart that illustrates the program logic and a description of each section and subroutine. In addition, all arrays, variables and strings are listed and defined, and a sample program listing with a complete list of symbols and references is provided.

50547 (UCRL—82276(Rev.1)) **Leak testing requirements at a research facility.** Conner, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Apr 1979. Contract W-7405-ENG-48. 9p. (CONF-790612—2). P 02/MF A01.

From Vacuum technology conference; Boston, MA, USA (5 Jun 1979).

Since September, 1952, Lawrence Livermore Laboratory has conducted pioneering research in applied science. A vital part of this activity has been the development of a variety of high vacuum and ultrahigh vacuum systems. Leaks occur in everything, including vacuum systems. The mass spectrometer leak detection equipment is described.

50548 (UCRL—83008) **Coherent fiber optics test techniques.** Reedy, R.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jul 1979. Contract W-7405-ENG-48. 35p. (CONF-790838—1). P 03/MF A01.

From 23. annual international symposium of the Society of Photographic Instrumentation Engineers; San Diego, CA, USA (27 Aug 1979).

We have found that reliance on theoretical models or incomplete manufacturers data is not adequate for predicting the result of combining optical and electro-optical components into a system. The complete imaging characteristics of each component must be accurately known if reliable predictions are expected. Inhouse testing then is desirable where possible. Some components have well estab-

lished evaluation procedures. Others such as coherent fiber optics, require various test techniques some well established and others must be devised if complete characterization is needed. This is especially true where changes in magnification are a feature of the bundle. A description of the techniques we use for testing the MTF, image rotation, magnification, image size variation, distortion, shear, transmission efficiency, transmission variation, transmission defects, flatness and acceptance angle are included in this paper.

50549 Mass spectrometer for analyzing hydrogen-ion species. Ehlers, K.W.; Leung, K.N.; Williams, M.D. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **50**: No. 8, 1031-1033(Aug 1979).

The design of a compact, high-resolution 180 ° magnetic deflection mass spectrometer for the study of positive and negative hydrogen-ion species is described.

50550 Time-resolved fluorimetry via a new cross-correlation method. Ramsey, J.M.; Hieftje, G.M.; Haugen, G.R. (Indiana University, Chemistry Department, Bloomington, Indiana 47405). *Appl. Opt.;* **18**: No. 12, 1913-1920(15 Jun 1979).

A new instrument for the measurement of short fluorescence lifetimes is discussed and characterized. The instrument is basically an implementation of the cross-correlation between the excitation source and the induced fluorescence response. Such an approach, with a mode-locked argon-ion laser as the source, is shown to be capable of measuring lifetimes as short as 80 psec with a precision of 10 psec.

50551 Pulse height analyzer with automatic differential deadtime correction. Byrd, J.S.; Goosey, M.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). *Nucl. Instrum. Methods;* **158**: No. 2, 565-569(15 Jan 1979).

A 4096-channel pulse height analyzer is described that features automatic differential deadtime correction of spectra at input rates up to 5 X 10^4/s.

50552 Digital readout for flash chambers. Dalton, C.G.; Krausse, G.J. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **158**: No. 1, 289-292(1 Jan 1979).

With the advent of low-cost honeycomb extrusions of polypropylene sheets, flash chambers have become attactive for large detector arrays. Optics and photographic readout systems, however, are costly and unsuitable for large detectors. This paper reports on a new low-cost electronic readout system for flash camera.

50553 Microprocessor controlled dual parameter ADC system with a CAMAC interface. Perry, D.G.; Nickell, J.D. Jr. (Los Alamos Scientific Lab., NM (USA)). *Nucl. Instrum. Methods;* **154**: No. 3, 589-594(1 Sep 1978).

Presented here is the design of a dual parameter ADC system which is controlled by a microprocessor and also interfaced to CAMAC. The system was designed to be mobile in that it may work wherever there is a CAMAC crate. In such cases where the CAMAC system is inoperative, the system may operate in a stand-alone mode.

50554 Viscometer test cell (19 Jan 1979) (Engineering Materials). (Sandia Labs., Albuquerque, NM (USA)). (CAPE—2642).

45 drawings.

A field instrument to measure the rheological characteristics of drilling mud at temperatures up to 500°F and pressures up to 12,500 psi is described. The equipment provides direct determination of fluid viscosity under simulated down hole conditions and consists of a rotational viscometer packaged in a high temperature, high pressure vessel. Heat is applied by electric resistance heaters and pressure is applied by a hand operated hydraulic pump. The unit which weighs approximately 60 pounds and is portable has been used to measure the properties of water based and oil based drilling fluids. (FS)

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 49485

50555 Laboratory studies of an improved carbon/oxygen log. Hearst, J.R. (Univ. of California, Livermore). *Log Anal.;* **19**: No. 6, 26-28(Nov 1978).

A new method of taking carbon/oxygen logs has been tested in the laboratory. The method uses a 15-cm-diameter by 15-cm-long NaI detector. At low carbon/oxygen atomic ratios (below 0.1), this detector provides about four times the resolution of previously reported logs, permitting carbon to be measured within 1 at. %.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

50556 (MHSMP—79-22) **Building 11-14A incident investigation.** Slape, R.J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1979. Contract EY-76-C-04-0487. 51p. P 04/MF A01.

On March 30, 1977, an explosion occurred in Building 11-14A, Bay 8, during a contact machining operation. An immediate investigation, under the direction of an Energy Research and Development Administration (ERDA) investigating board, was conducted. The board concluded the accident resulted from one or a combination of four probable causes. A follow-up investigation was conducted to determine the single most probable cause for the incident. It was concluded that the explosive billet on the lathe was initiated somewhere on the top circumferential area of the billet indicating that the most probable cause for the initiation was a machinist mallet used in centering operations.

50557 (MHSMP—79-25) **Chemical reactivity test: a compatibility screening test for explosives.** Myers, L.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Apr 1979. Contract EY-76-C-04-0487. 11p. (CONF-7905102—1). P 02/MF A01.

From Symposium on compatibility of plastics and other materials with explosives, propellants, and pyrotechnics; Albuquerque, NM, USA (15 May 1979).

The chemical reactivity test is used to evaluate the compatibility of explosives with other materials. This test has been in use at Pantex for more than 15 years, and during this time several improvements have been made in the test apparatus. The basic test apparatus consists of a gas chromatograph with subambient temperature programming. A special inlet and a calibration system were designed and added to the chromatograph. Samples are conditioned in specially designed sample holders. A description of the test apparatus is given and data from a variety of different types of materials with explosives are discussed. Examples of various types of information which can be obtained from the test are also discussed.

50558 (UCRL—52692) **Gas evolution and weight loss from thermal decomposition of PBX-9404 below 100°C.** Leider, H.R.; Seaton, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Mar 1979. Contract W-7405-ENG-48. 20p. P 02/MF A01.

Weight loss, gas evolution, and changes in composition that occurred during thermal decomposition of PBX-9404 were studied. It was determined that decomposition of the nitrocellulose (NC) binder was responsible for all observed changes. After a time, the rate of decomposition accelerated markedly - a phenomenon that has been observed in explosives and propellants containing NC. The onset of accelerated decomposition of PBX-9404 resulted in a fractional-weight loss of 0.004. The initial kinetics of the decomposition reactions were examined and calculations based either on weight loss or gas evolution indicated a zero-order process. The activation energies of decomposition derived from weight loss data and from the amount of gas evolved were nearly the same: 26.9 and 28.1 kcal/mol, respectively.

NUCLEAR

50559 Necessary conditions for the initiation and propagation of nuclear-detonation waves in plane atmospheres. Weaver, T.A.; Wood, L. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., A;* **20**: No. 1, 316-328(Jul 1979).

The basic conditions for the initiation of a nuclear-detonation wave in an atmosphere having plane symmetry (e.g., a thin, layered fluid envelope on a planet or star) are developed. Two classes of such a detonation are identified: those in which the temperature of the plasma is comparable to that of the electromagnetic radiation permeating it, and those in which the temperature of the plasma is much higher. Necessary conditions are developed for the propagation of such detonation waves for an arbitrarily great distance. The contribution of fusion chain reactions to these processes is evaluated. By means of these considerations, it is shown that neither the atmosphere nor oceans of the Earth may be made to undergo propagating nuclear detonation under any circumstances.

WEAPONRY

REFER ALSO TO CITATION(S) 50636

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 50562, 50619

50560 Problems in interpreting tree-ring δ ^{13}C records. Farmer, J.G. (Woods Hole Oceanographic Inst., MA). *Nature (London);* **279**: No. 5710, 229-231(17 May 1979).

The trend in whole wood δ ^{13}C from 1883 to 1968 for tree rings of an American elm, grown in a non-forest environment at sea level in Falmouth, Cape Cod, Massachusetts (41°34'N, 70°38'W) on the northeastern coast of the US is reported. Examination of the δ ^{13}C trends in the light of various potential influences demonstrates the difficulty of attributing fluctuations in $^{13}C/^{12}C$ ratios to a unique cause and suggests that comparison of pre-1850 ratios with temperature records could aid resolution of perturbatory parameters in the twentieth century. (JGB)

50561 Review of the physical characteristics of sulfur aerosols. Whitby, K.T. (Univ. of Minnesota, Minneapolis). *Atmos. Environ.;* **12**: No. 1-3, 135-159(1978).

The review showed that the physical size distributions are well characterized by a trimodal model consisting of three additive log-normal distributions: the nuclei mode with geometric mean size by volume (DGV) of 0.015 to 0.04 μm; the accumulation mode with DGV of 0.15 to 0.5 μm; and the coarse particle mode with DGV of 5 to 30 μm. The fine particles, less than 2 μm dia, are essentially independent in formation, transformation, and removal from coarse particles, above 2 μm dia. The sulfate is nearly all in the accumulation mode and has the same size distribution as the physical accumulation mode distribution. The average sulfate aerodynamic geometric mean diameter was 0.48 +- 0.1 μm. Concentrations ranged from a low of 0.04 μg/cu m over the remote oceans to over 80 μg/cu m under polluted conditions over the continents. There is considerable theoretical and experimental evidence that even if most of the mass for the condensational growth of the accumulation mode comes from hydrocarbon conversion, sulfur conversion provides most of the nuclei. 115 references.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 49471, 49476, 50397, 50560, 50570, 50575, 50590, 50614, 50621, 50627

50562 (DOE/EV—0040) **Multistate atmospheric power production pollution study - MAP3S. Progress report for FY 1977 and FY 1978.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1979. Contract W-7405-ENG-48. 413p. P 18/MF A01.

Research progress on the transport, transformation, and fate of pollutants released by energy-related activities is summarized. Information is reported under the following section headings: power production emissions; non-power production emissions; measuring pollutants and their properties; regional pollutant distribution; transport; pollutant transformation; surface removal processes; wet removal processes; weather and climate modification; numerical modeling and analysis; special activities; and, MAP3S research directions. (JGB)

50563 (EML—356) **Environmental Measurements Laboratory environmental quarterly, March 1—June 1, 1979.** Hardy, E.P. Jr. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Jul 1979. 550p. P 23/MF A01.

Environmental data that became available during the period from March 1 to June 1, 1979 are summarized. This report is divided into four main parts; interpretive reports and notes; EML Environmental Program data; data from sources other than EML; and recent publications related to environmental studies. The initial section consists of interpretive reports and notes dealing with Chinese nuclear test debris in the stratosphere, seawater concentrations of radium and thorium, radium in human bone, global fallout and dispersal of oceanic pollutants, chemical composition of wet and dry deposition, and strontium-90 in diet through 1978. The end of this first section consists of seven papers given at the 1978 New England Conference on Current Developments in Spectrochemical Excitation and Analysis. Individual papers (in scope) were abstracted and indexed for ERA/EDB. Subsequent sections include tabulations of radionuclide and trace metal concentrations in surface air, and ^{90}Sr concentrations in deposition, milk, diet, and tap water. A bibliography of recent publications related to environmental studies is also presented.

50564 (IVL-B—479) **Station for measurements on the air at Orsala, Sweden 1968—1978: aims and reached results.** Brosset, C. (Swedish Water and Air Pollution Research Lab., Stockholm). Dec 1978. 36p. (In Swedish). U 03/MF A01.

The station for measurements on the air is situated 40 km to the south of Gothenburg. It has been operative since 1968. The aim of the activity has been to determine the background proportions of different air pollutants and their variations with time within an area characteristic for the Swedish west coast. Furthermore the origins of the different pollutants have been studied as well as the production and the transport of them and material useful for the determination of the ecological effects of different industrial emissions has been collected.

50565 (SAND—79-8246) **Optical particulate size measurements using a small-angle near-forward scattering technique.** Wang, J.C.F. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 48p. (CONF-790740—1). P 03/MF A01.

From 2. symposium on transfer and utilization of particulate control technology; Denver, CO, USA (23 Jul 1979).

Techniques for measuring particle size distributions in the range of 1 to 50 μm based on light scattering principles were reviewed and examined to define appropriate diagnostic tools for applications in fossil fuel combustor environments of advanced power systems. Light scattering at forward small angles (1 to 5°) was identified as one of the most promising optical techniques based on a systematic theoretical investigation using Mie calculations. To verify the theoretical predictions, a laboratory bench experiment was initiated in this near-forward small-angle configuration using monodispersed and polydispersed particles of known physical properties of different refractive indices and sizes.

50566 Concentration of sulfate in precipitation. Scott, B.C.; Laulainen, N.S. (Battelle, Pacific Northwest Laboratories, Richland, WA 99352). *J. Appl. Meteorol.;* **18**: No. 2, 138-147(Feb 1979).

Two case studies are used to examine the relationship of the sulfate concentration in surface precipitation to the microphysical characteristics of the precipitating cloud systems. The data from one case study support the contention that existing sulfate aerosol was incorporated into cloud water by the nucleation process and accounted for nearly all of the observed cloud and precipitation water sulfate concentration. These activated sulfate particles comprised nearly 60% of the clear-air sulfate mass concentration. Once nucleated, the sulfate particles accumulated water through the condensation process and were subsequently deposited at the surface after accretion on large snowflakes. The presumption of aqueous phase sulfate oxidation of SO_2 was not necessary to account for the observed sulfate concentrations.The data from the second case study are more limited and difficult to interpret. Nucleation and below cloud washout appeared to be the main contributors to the surface sulfate concentration in precipitation water.

50567 Preparation of dilute gas (NO, CO, or hydrocarbon): analytical standards by a gas permeation membrane method. Ibusuki, T.; Imagami, K.; Sakuma, M. *Nippon Kagaku Kaishi;* **6**: 882-887(Jun 1978). (In Japanese).

Accurate gas concentrations of nitric oxide, carbon monoxide, methane, ethane, and propane of < 25 ppM were obtained by permeation through 125 and 813μ FEP Teflon membranes according to Ficks gas diffusion theory, i.e., the diffusion depended on the gas pressure and the membrane temperature. Deviations from predicted concentrations increased with increasing gas molecule size and with decreasing temperature. A method for determining the length of time to steady-state permeation was developed, and its dependence on the gas used, the temperature, and the membrane thickness was elucidated.

50568 Chemical properties of tropospheric sulfur aerosols. Charlson, R.J.; Covert, D.S. *Atmos. Environ.;* **12**: No. 1-3, 39-53(1978).

From Yugoslovia Academy of Science and Arts international sulfur atmospheric symposium; Dubrovnik, Yugoslvia (7 Aug 1977).

A review showed that sulfur, largely in the form of the sulfate ion, is a substance which frequently governs the physicochemical nature of submicrometer particles. In the eastern third of the US, the accumulation mode aerosol can be described semiquantitatively (with respect to its chemistry) as a collection of particles composed of impure sulfate compounds ranging from H_2SO_4 to $(NH_4)_2SO_4$. The impurities include metals, inorganic ions, e.g., nitrate, and a wide variety of trace organic compounds. These substances are on the average mixed internally rather than externally. Sulfate compounds as well as other substances and impurities cause the submicrometer particles to accumulate relatively large amounts of liquid water. The review also covers the role and importance of the chemical composition of atmospheric aerosol particles; molecular forms of sulfur in tropospheric aerosols; the hygroscopic properties of sulfate aerosols; refractive index effects of sulfur in aerosols; and substance coexisting with sulfur in tropospheric aerosols. Flow diagram, tables, graphs, and 59 references were included.

50569 Techniques for determining the chemical composition of aerosol sulfur compounds. Newman, L. (Brookhaven National Lab., Upton, NY). *Atmos. Environ.;* **12**: No. 1-3, 113-125(1978).

A review covers sampling methods; the use of general analytical techniques in the determination of the chemical composition of aerosol sulfur compounds; classical wet chemical techniques; solvent separations; thermal volatilization for the separation and identification of decomposable sulfate compounds; thermometric methods, e.g., to determine the amount of sulfur in the plus-four and plus-six oxidation states; ESCA and IR techniques; laser Raman spectroscopy; the use of a diffusion processor in conjunction with a condensation nuclei counter for the determination of numerical size distribution of suboptically sized particles; and future considerations, e.g., the clever use of gas-phase chemistry as an untapped resource.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 50563, 50580, 50614

50570 (LBL—9080) **Annual environmental monitoring report of the Lawrence Berkeley Laboratory, 1978.** Schleimer, G.E. (ed.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 28p. P 03/MF A01.

Environmental monitoring data are reported for accelerator produced radiation; radionuclide measurements and release data from atmospheric and water sampling; population dose equivalent resulting from LBL operations; and non-radioactive pollutants. (HLW)

50571 (RFP-ENV—78) **Annual environmental monitoring report, US Department of Energy, Rocky Flats Plant, January—December 1978.** Howerton, R.D. (ed.). (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 15 May 1979. Contract EY-76-C-04-3533. 54p. P 04/MF A01.

An environmental monitoring program that included the sampling and analysis of air, water, and soil on and off the plant site was conducted. Particulate samples were collected from air samplers that operated continuously at the plant perimeter and in 12 communities located near the plant. An analysis of these samples indicated that the concentrations of airborne plutonium at perimeter and community locations were identical and were within the range attributed primarily to fallout from atmospheric nuclear weapons testing. The sanitary water was processed through a tertiary treatment facility before discharge, and the discharges were monitored for compliance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit. Violations of NPDES daily limits occurred on nine occasions and were related to fluoride, pH, suspended solids, and biochemical oxygen demand. In all cases, the causes for these violations were identified and corrective actions taken. The plutonium, uranium, americium, and tritium radioactivity concentrations measured in Great Western Reservoir and Standley Lake during 1978 all were found to be less than 0.07% of the applicable DOE Radioactivity Concentration Guides. Drinking water from nine communities was monitored for plutonium, uranium, and americium. An assessment was made of the potential Plant contribution to public radiation dose. Total dose to the population living within 80 kilometers was calculated using the community radiation dose values. (JGB)

50572 (SAND—78-2075C) **Effects of wind shift and cross-plume concentration models on calculated accident consequences.** Schueckler, M.; Aldrich, D.; Bayer, A. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.); Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 9p. (CONF-790519—2). P 02/MF A01.

From European nuclear conference; Hamburg, F.R. Germany (6 May 1979).

The dispersion of released atmospheric contaminants is normally treated using a Gaussian plume model. To simplify this treatment, the U.S. Reactor Safety Study (RSS) replaced the Gaussian cross-plume shape with a uniform, or top-hat, distribution. This simplification has two effects on the calculation of accident consequences. First, consequences calculated using the top-hat are limited to the assumed width of the distribution, whereas in actuality they might occur over either wider, or narrower, areas. Second, all persons affected by the plume at a given distance are exposed to the same average radionuclide concentrations, rather than the distribution from 0 to some peak value. To improve upon the top-hat treatment, a cross-plume concentration distribution with four distinct concentration steps was used in phase A of the German RSS. Using the phase A German RSS consequence model, a series of reactor accident consequence calculations was performed using eight different cross-plume concentration models. The results of these calculations are compared and discussed. To account for hourly wind direction changes a wind shift model has been proposed for use in the German RSS. The effects of this model on calculated accident consequences are also discussed. From the discussions, the following conclusions can be drawn: (1) the U.S. top-hat distribution overestimates early fatalities andslightly underestimates latent cancer fatalities; (2) for the calculation of latent cancer fatalities, a top-hat distribution with outer distances $y/\delta/sub\ y/ = 2$ (width = $4\delta/sub\ y/$) is adequate; (3) for the calculation of early fatalities, a 2-step distribution with outer distances $y/\delta/sub\ y/ = (1.0, 2.0)$ might be adequate; and (4) use of the proposed wind shift model results in a moderate reduction in calculated early fatalities for releases of long duration. (ERB)

50573 Radionuclides in the south pole atmosphere. Maenhaut, W.; Zoller, W.H.; Coles, D.G. (Department of Chemistry, University of Maryland, College Park, Maryland 20742). *J. Geophys. Res.;* **84**: No. C6, 3131-3138(20 Jun 1979).

Surface air concentrations of ^{222}Rn, ^{210}Pb, ^{7}Be, and fission products at the geographic south pole have been determined during the 1973—1974 and 1974—1975 austral summer seasons. The ^{222}Rn concentration was generally very low (0.3—0.4 pCi per standard cubic meter). However, on some days, very high radon levels, indicative of 'radonic storms,' were observed. The concentrations of fission products, from new nuclear tests in 1974, increased as a function of time. This indicated that the stratospheric reservoir of nuclear debris was still drastically changing some 3—4 months after the nuclear detonations. The ^{7}Be and fission product concentrations from old debris origin showed a good correlation with the concentrations of some atmospheric trace elements, such as S and Br. This and other facts suggested a stratospheric origin for those trace elements. There were also several indications which pointed to a substantial stratospheric source of ^{210}Pb during the austral summer season. The size distribution data for the various fission products differed from the ^{7}Be size distribution data, possibly as a result of the different age of the ^{7}Be-bearing aerosols or mode of transport to the antarctic continent.

50574 Time-dependent calculations of the vertical distribution of ^{222}Rn and its decay products in the atmosphere. Beck, H.L.; Gogolak, C.V. (Environmental Measurements Laboratory, U. S. Department of Energy, New York, New York 10014). *J. Geophys. Res.;* **84**: No. C6, 3139-3148(20 Jun 1979).

A model has been developed to stimulate the one-dimensional time-dependent vertical diffusion of ^{222}Rn and its decay products in the atmosphere. Computed activities and activity ratios as a function of height above the ground are in excellent agreement with experimental data. The simulations indicate that near the air-ground interface a quasi steady state is reached within a few hours after establishment of a particular atmospheric mixing regime. Radioactive equilibrium between radon and its short-lived daughters is approached at all heights except for very close to the ground during weak mixing conditions.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 50601

50575 (CONF-790739—1) **Regional environmental studies: application of the Geoecology Data Base.** Olson, R.J.; Klopatek, J.M.; Emerson, C.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 26p. P 03/MF A01.

From Harvard computer graphics week '79; Cambridge, MA, USA (15 Jul 1979).

Regional studies examine the spatial, temporal, and functional characteristics of geographic areas whose size and boundary configuration often depend on the definition of a particular problem. Thus, reference may be made to ecological, urban, economic, political, or abstract regions. To address environmental problems at the regional scale, the county-level Geoecology Data Base was developed. Using selected variables from existing data sources, a standardized digital data base was created for the conterminous United States. Over 1000 variables on file for county-subcounty units provide data on terrain, water resources, forestry, vegetation, wildlife, agriculture, land use, climate, air quality, population, and energy. The data base is described, and the utility of the county-level data base is illustrated with three examples. The Geoecology Data Base is utilized in conjunction with statistical analysis (SAS) and cartographic display (SYMAP, EZMAP, etc.) programs to both characterize regional environmental systems and to delineate possible environmental impacts. Much of the effort involved in creation and expansion of the Geoecology Data Base consists of obtaining and editing diverse inventory and monitoring files. An integral aspect of this activity is the promotion of data exchange through increased awareness of available data and development of more efficient exchange methods. The three examples involve regional environmental studies. First, future patterns of projected levels of SO_2 are overlaid on SO_2-sensitive agricultural crops and forest resources.

Secondly, those areas of potential natural vegetation of the United States as modified or replaced by current land use are depicted.Finally, an ecological evaluation of potential wilderness areas using a number of county-subcounty ecological parameters is discussed.

REGULATIONS

REFER ALSO TO CITATION(S) 50169, 50177, 50178, 50179, 50180, 50181, 50182, 50183, 50184, 50185, 50186, 50187, 50188, 50189, 50190, 50191, 50192

50576 (CONF-790405—19) **National air quality policies and developing energy technologies.** Garvey, D.B.; Streets, D.G. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 24p. P 02/MF A01.

From AICE meeting; Houston, TX, USA (1 Apr 1979).

The Clean Air Act Amendments of 1977 and subsequent EPA regulations are discussed. Three aspects of air quality management are emphasized: prevention of significant deterioration, nonattainment, and new source performance standards. The current status of EPA regulations to implement those sections of the law is examined. (JGB)

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 50626

50577 (CONF-790378—1) **Self-organizing characteristics of ecological communities.** DeAngelis, D.L.; Post, W.M.; Travis, C.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 34p. P 03/MF A01.

From Symposium on problems of a theory of self-organizing systems; Bremen, F.R. Germany (28 Mar 1979).

General patterns of ecological succession are reviewed. Phenomena in which ecosystems create orderly patterns in time and space are illustrated. The use of mathematical models for studying ecosystem self-organization in time and space is discussed. (JGB)

50578 **Chemical and physical properties of lignite spoil material and their influence upon successful reclamation.** Hons, F.M. College Station, TX; Texas A and M Univ. (1978). 150p. L 78-17,183.

Thesis (Ph. D.).

A three year forage crop study was initiated in 1975 at the Big Brown mine in Freestone County, Texas, to determine the yield and reclamation potentials of various grasses and legumes on lignite mined soil. Grasses used in the study included NK-37 bermudagrass, Coastal bermudagrass, Kelingrass, bahiagrass, and Callie Giant bermudagrass. Legumes utilized included Yuchi arrowleaf clover, Crimson clover, and alfalfa. Kleingrass, Coastal bermudagrass, and Yuchi arrowleaf clover proved to be the most productive species tested. Statistical analyses demonstrated that nitrogen was the most limiting fertilizer nutrient necessary for the production of grasses on the mined soil. Phosphorus was the most important fertilizer nutrient for the adequate legume production. Nitrogen availability because of NH_4^+ fixation should not be a problem on a field basis as demonstrated by recoveries of applied NH_4^+—N fertilizers.Soil reaction declined after mining until the oxidizable pyrite was consumed. Soil pH values then stabilized and did not change significantly during the three year period of study. The final mean pH of the area was approximately 4.4. Soil oxygen concentrations were correlated with soil moisture by volume and depth in linear regression models. Depth explained the soil oxygen concentrations in wet portions of the year; soil moisture explained the soil oxygen concentration in drier portions of the year.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 50571, 50621, 50625, 50627, 50635

50579 **Sulfate adsorption and sulfur fractions in a highly weathered soil under a mixed deciduous forest.** Johnson, D.W.; Henderson, G.S. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Soil Sci.;* **128**: No. 1, 34-40(Jul 1979).

A laboratory study was undertaken to test the hypothesis that sulfur is accumulating by sulfate adsorption in a mixed deciduous forest soil. Sesquioxide-rich subsurface soils had a large reservoir of phosphate-soluble, adsorbed sulfate-S (2700 kilograms per hectare), but would not permanently adsorb more. Surface soils had no detectable adsorbed sulfate, but a substantial reserve of water-soluble sulfate-S (110 kilograms per hectare). Surface soils were also capable of adsorbing more sulfate into forms not extractable with water or phosphate solution. The high proportion of water-soluble sulfate appears to play an important role in determining sulfate concentrations in headwater streams. During peak storm flow periods, sulfate concentrations in headwater streams increase, and it is hypothesized that this is due to leaching from surface horizons in the variable source areas of the watershed. It is hypothesized further that the water-soluble sulfate pool in surface horizons is active in sulfur-cycling processes, whereas water-insoluble sulfate in subsurface horizons constitutes an inactive, long-term sulfur reserve.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 50571, 50593, 50594, 50595, 50614

50580 (CONF-790602—53) **Potential importance of resuspension during chronic releases to the atmosphere.** Kocher, D.C. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. P 02/MF A01.

From ANS annual meeting; Atlanta, GA, USA (3 Jun 1979).

During chronic releases of radionuclides to the atmosphere, airborne concentrations and resulting radiation exposures are often calculated by assuming that the contributions from resuspended activity are negligible compared with the contributions from direct atmospheric transport. In this paper, models which have been proposed to describe resuspension are used to estimate air concentrations and radiation exposures from resuspension for a chronic release time corresponding to an operating lifetime of a nuclear facility. The potential importance of resuspension is assessed by comparing the results with the same quantities from direct atmospheric transport. Application of available resuspension models to long-term chronic releases to the atmosphere results in resuspension concentrations which cannot be neglected compared with concentrations from direct atmospheric transport. If the resuspension factor is to be used in radiological assessments, further investigation into the proper values of the deposition velocity, initial resuspension factor, and resuspension decay constant for use in the models is needed. In the absence of a verified resuspension model, Horst has shown that resuspension can be conservatively accounted for by calculating air concentrations from direct transport without depletion due to deposition. (EDB)

50581 (COO—2447-6) **Behavior of technetium-99 in soils and plants. Final report, April 1, 1974—December 31, 1978.** Gast, R.G.; Landa, E.R.; Thorvig, L.J.; Grigal, D.F.; Balogh, J.C. (Minnesota Univ., St. Paul (USA). Dept. of Soil Science). Jan 1979. Contract EY-76-S-02-2447. 128p. P 07/MF A01.

Studies described in this report were aimed at establishing the magnitude and mechanisms of ^{99}Tc sorption by soils and uptake by plants. Results show that ^{99}Tc was sorbed from solution over a period to two to five weeks by 8 of 11 soils studies. The slow rate of sorption, the lack of sorption by low organic matter soils, the elimination of sorption following sterilization and increased sorption following addition of dextrose all point to a microbial role in the sorption process. However, it has not been established whether this is a direct or indirect role nor is it possible to clearly predict the conditions under which sorption will occur. Results of plant uptake studies show that ^{99}Tc can be taken up and translocated into the photosynthetic tissue of higher plants with concentrations in seeds being much less than in vegetative tissue. Technetium-99 was also shown to be toxic to plants at low concentrations and evidence suggests that this is a chemically rather than radiologically induced toxicity. However, this remains to be completely resolved as well as whether there is a threshold level of ^{99}Tc required before toxicity occurs. Studies of short-term, dynamic, aerobic systems indicated that ^{99}Tc moves through the soil as a relatively large anion exhibiting characteristic miscible displacement with some asymmetric tailing. ^{99}Tc exhibits greater retention that Cl^-, which may be attributed statistically to weak complexion by organic matter. It is unlikely that this retention phenomenon is related to the static sorption activity reported in the first part of this study.

50582 **Design and utilization of a continuous, digital-output, environmental radon measuring instrument.** Spitz, H.B. New York, NY; New York Univ. (1978). 157p. L 78-18,466.

Thesis (Ph. D.).

A continuous, digital-output radon measuring instrument has been designed, calibrated, and employed in a field program to measure environmental airborne radon. The unit operates without air movers on pumps and is suited for long-term monitoring studies.

Radon, but not the daughters, diffuses into the sensitive portion of the detector, a hemispherical region between the central anode and the cathode. Short-lived alpha-emitting daughters of radon are electrostatically collected on a hemispherically-shaped lucite light pipe which is covered with silver activated zinc-sulfide [ZnS(Ag)]. Aluminized mylar (1 mg/cm^2) covers the ZnS(Ag) to provide a conducting surface for the anode. The unit was calibrated with known concentrations of ^{222}Rn and background determined in an aged-air, radon-free environment. The number of alpha counts in a preselected time interval is displayed and can be printed on paper tape. The detection limit for a 1l unit in a 24-h period is 0.04 pCi/l and in a 1-hr period is 0.18 pCi/l. Measurements of radon indoors and outdoors were taken in homes in Grand Junction, Colorado before and after uranium mill tailings were removed as well as in a control location where tailings are known to be about. The average indoor and outdoor radon concentration at the control site was 0.92 pCi/l and 0.73 pCi/l, respectively. In a typical house where tailings were present, the indoor radon content range from 16 to 240 pCi/l. Long-term measurements were performed in a wood frame house in New Jersey. Simultaneous measurements were made in the basement, first floor and outside. Ventilation was the most significant factor influencing radon buildup indoors. The effect of barometric pressure and wind speed was also investigated.

SOIL

REFER ALSO TO CITATION(S) 49560, 49568

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 50598

50583 (CONF-790331—5) **Constraints on the design of flow measuring structures over a large dynamic flow range.** Hickey, M.J.; Holmes, R.M. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 11p. P 02/MF A01.

From Waste management seminar; Oak Ridge, TN, USA (6 Mar 1979).

Topographical restraints for design storm flow are described as sharp-crested weirs for low flows in series with broad-crested weirs for the high flows. These design selections are considered to be most economical while providing the specified flow measuring capabilities for movement of radionuclides from the solid waste disposal areas into the surface streams around ORNL. (PCS)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 49854

50584 Analysis of combustion within surface mine spoils and of its consequent effects on the environment and reclamation practices. Leonhart, L.S. Tucson, AZ; Univ. of Arizona (1978). 115p. L 78-21,918.

Thesis (Ph. D.).

In certain surface coal mines in the southern Rocky Mountain Coal Province, waste coal and other combustible materials have been observed to ignite spontaneously at depths as great as 25 feet, provided that there is a sufficient flow of oxygen from the surface. Subsurface fires arising from this phenomenon have a potential for transferring significant quantities of heat to the surface environment, thereby impairing revegetation success. Venting through cracks, fissures, and subsurface voids can result in the release of noxious gases into the atmosphere and the deposition of coal tars and other contaminants at the ground surface. The research explores factors related to sustained combustion within mine spoils, identifies conditions useful for spoil fire recognition, and suggests methods and alternatives available for control. The nature and extent of environmental impacts related to air and water quality, mine reclamation, health, and safety which arise from spoil fires are also evaluated. To assist resource managers and mine planners, a monitoring strategy is presented which employs remote imaging and computer simulation for the assessment of the spoil fire hazard both in advance of and during mining. The methods described are also applicable to the environmental assessment of other naturally occurring and/or man induced phenomena involving subsurface heat generation. The approach is shown to be effective in ascertaining various parameters related to the nature of the heat source, including its magnitude and depth below the surface. The potential for assessing heat transfer dynamics is also discussed.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 50163, 50575, 50601

50585 (RLO—2229/T15-7) **Comprehensive bibliography and index of environmental information for the northwest and lower Yukon-Kuskokwim areas of Alaska.** Buck, E.H.; Allen, A.; Olshansky, R.B.; Mitchell, M. Jr.; Wilson, M.S. (Alaska Univ., Anchorage (USA). Arctic Environmental Information and Data Center). Jan 1979. Contract EY-76-S-06-2229-015. 320p. P 14/MF A01.

This bibliography and index was compiled to provide increased access to environmental information pertinent to the Northwest and lower Yukon-Kuskokwim areas of Alaska. These two areas were chosen because they are of vital importance from an energy resource standpoint and contain large Native land selections and wilderness withdrawals. The bibliography and index is divided into the following sections: master bibliography; author index; geographic index, including three parts - (a) geographic name with latitude and longitude, (b) latitude and longitude with geographic name, and (c) township and range with geographic name; three maps of the areas covered by the geographic index; earth sciences index; biological (taxonomic) index; and general keyword index. (JGB)

REGULATIONS

REFER ALSO TO CITATION(S) 50169, 50177, 50178, 50179, 50180, 50181, 50182, 50183, 50184, 50185, 50186, 50187, 50188, 50189, 50190, 50191, 50192

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 50577, 50626, 50629

50586 (UCID—18187) **Papago Indian Reservation water sample analyses.** Higgins, G.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 May 1979. Contract W-7405-ENG-48. 20p. P 02/MF A01.

Results of optical emission spectrographic analyses of water samples collected on the Papago Indian Reservation in Southern Arizona are tabulated. The results are not interpreted or discussed.

50587 Growth rate influence on the chemical composition of phytoplankton in oceanic waters. Goldman, J.C. (Woods Hole Oceanographic Institution, MA); McCarthy, J.J.; Peavey, D.G. *Nature (London);* 279: No. 5710, 210-214(17 May 1979).

The chemical composition of oceanic phytoplankton (by atoms) typically occurs in the proportions $C_{106}N_{16}P_1$. Yet, in laboratory growth conditions these proportions are only observed for marine phytoplankton at high growth rates when non-nutrient limitation is approached. Thus growth rates of natural phytoplankton populations in oceanic waters may be near maximal and hence non-nutrient limited. The uniformly low biomass and residual nutrient levels in such waters does not preclude the possibility of high growth rates because zooplankton grazing and nutrient regeneration within the euphotic zone may keep this highly dynamic system in a balanced state.

50588 Plankton biology of acidic strip-mine impoundments. Mayhew, E.A. Kent, OH; Kent State Univ. (1978). 196p. L 78-21,085.

Thesis (Ph. D.).

Monthly water samples were collected from three strip-mine impoundments in Tuscarawas County, Ohio. One lake was formed in 1918, and two were formed in 1967. The pH of the lakes varied from 9.0 to 3.2, and vegetation in the watersheds varied from 100% to 50% coverage. The three lakes provided a comparison of stages in recovery from acidic conditions. Phytoplankton and chemical samples were collected from the surface, 2 to 3 m, and 5 to 7 m. Zooplankton was collected by horizontal, vertical, and bottom to 3 m closing-net tows. Data were obtained to determine the effect of physico-chemical factors on the ecology of the phytoplankton and zooplankton. Algal cell numbers, algal biovolume, chlorophyll a, and bioseston were analyzed to obtain estimates of primary production, and a trophic state index was calculated. Zooplankton concentrations were determined to obtain estimates of secondary production. All three lakes were found to be eutrophic. The number of taxa of phytoplankton and zooplankton increased slightly as pH increased from 3.2 to 9.0; however, the number of taxa found in the most acidic lake was far higher than has been reported for acidic impoundments. The planktonic algae differed taxonomically from those described for periphytic communities subjected to acidic discharges. Temperature, pH, conductivity, dissolved oxygen, and concentration of abioseston were compared with depth over an annual cycle.

Flocculation was produced by heavy rainfall in the lake of pH 3.2. The causes of the flocculation and its effects on algae were investigated in situ and in chambers in the laboratory. The rain-induced flocculation in the most acid lake caused the nonflagellated algae, chlorophyll, and bioseston to be concentrated in the lower meter of water. The flocculation of acidic lake water inthe laboratory duplicated these conditions. The importance of natural flocculation as a mechanism for recovery from the acidic condition is discussed.

50589 Productivity, population dynamics, and physiological ecology of the dwarf surf clam, Mulinia lateralis near a power plant intake canal, Southport, North Carolina. Williams, J.B. Raleigh, NC; North Carolina State Univ. (1978). 175p. L 78-20,068.
Thesis (Ph. D.).

From May 1975 to July 1976, populations of the dwarf surf clam, Mulinia lateralis, living in the lower Cape Fear River estuary, North Carolina, were sampled to determine seasonal changes of clam density, biomass, and length frequency and to relate the changes to different physical and biological factors. Patterns of recruitment to these populations were analyzed. Trawl studies and stomach content analysis were conducted to identify predators and their abundance. Results were combined with feeding rate experiments of blue crab, Callinectes sapidus. The final objective was to determine M. lateralis productivity and its contribution to the ecosystem. Seasonal density cycles were observed. Clam numbers were highest in the late winter and early spring (1976 highest with 4.18 x 10^{-3} kcal/m^2 per day), decreased to very low summer levels, then increased again during late fall. Recruitment of young clams was in late fall. Biomass displayed a seasonal pattern similar to density, except the peak occurred later in the spring. Fall decline in numbers was attributed to reduced recruitment and increased predator activity. Annual production ranged from 1.796 kcal/m^2 to 4.575 kcal/m^2. Measurements of clam oxygen uptake were made in 5 salinity concentrations (10, 15, 20, 25, and 30 ppt) and at 5 temperatures (15, 20, 25, 30, and 32°C). The relative effects of temperature and salinity on respiration were compared. The effect of temperature was greater than salinity; interaction effects between the two were significant. Respiration rates were highest at wider temperature ranges at middle salinities (15 to 20 ppt).

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 49444, 49460, 49476, 50400, 50563, 50570, 50588

50590 (PNL-RAP—35) Evaluation of environmental impacts of outer continental shelf petroleum development in the Pacific Northwest and Alaska. Mellinger, P.J.; Anderson, J.W.; Vanderhorst, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1979. Contract EY-76-C-06-1830. 134p. P 07/MF A01.

The scope of this report is to: describe the development of petroleum reserves on the Oregon, Washington, and Alaskan outer continental shelves (OCS); characterize the technology applicable to OCS development; identify the routine discharges to the marine and estuarine environment resulting from the petroleum resource development of the OCS; and discuss any possible ecological impact from these routine discharges. Components of the routine discharges to the marine environment from OCS development include metals in produced water, drilling muds, and borehole cuttings and chemicals in drilling mud. Hydrocarbons and oils are discharged to the oceans from ships' bilges and produced water and to the atmosphere as combustion products from ships and platform power generation sources and as evaporation products from offshore and land-based storage tanks. The number of discharged species is large and they occur as dissolved species, or suspended or settleable solids. Offshore technologies do exist to assure that the concentrations of discharged pollutants to the oceans and atmosphere are kept to a level that complies to regulatory limits. Where sufficient effluent data exist, it is concluded that long-term ecological effects from routine discharges have not been detected and appear not to occur. However, no environmental data gathered to date are sensitive enough to test a scientific hypothesis of the nature or magnitude of impact that would occur to a site-specific population or ecosystem from this type of release. Short-term effects are localized and short-lived and are therefore ecologically insignificant.

50591 Environmental effects of offshore oil production. Basile, B.P. Houston, TX; Univ. of Houston (1978). 289p. L 79-01,184.
Thesis (Ph. D.).

Analytical methodology for quantitation of alkanes, aromatic hydrocarbons and sulfur was developed and applied to the study of environmental effects of offshore oil production. Deuteriated alkanes served as internal standards for quantitation of environmental alkanes by gas chromatography alone. Detection limit for hydrocarbons was 50 ng/L in seawater and 100 ng/g in sediments and biological samples. Deuteriated analogs of aromatic hydrocarbons required mass spectrometry to distinguish them from the compounds being measured. Samples from seawater, sediments and well jackets (12 examined) contained petroleum alkanes while 7/14 flesh samples from the production platform contained alkanes. In all samples the biogenic alkanes, C_{15}, C_{17}, C_{21} and pristane were dominant. Representatives of the classes Bivalvia, Gastropoda, Hydrozoa and Anthozoa were obtained from the production, quarters and well jacket platforms. Alcyonaria and hydroids contained alkanes in the C_{22} to C_{32} region. Most samples from the production platform contained benzo[a]pyrene and methylnaphalenes. Surface plankton samples contained petroleum alkanes. Subsurface samples contained only biogenic hydrocarbons, n-C_{15}, n-C_{17} and pristane. Shrimp samples caught adjacent to the production platform contained alkanes. The dominant hydrocarbons in fish livers and muscle were the biogenic alkanes C_{15}, C_{17} and pristane. Some fish muscles contained low levels of petroleum hydrocarbons. Major conclusions were: (1) petroleum contamination of water was present in the area of study, but beyond 0.2 km of production platform the contamination cannot be ascribed to oil-field production activities, (2) biota and sediments outside the immediate vicinity of the production platforms do not contain petroleum hydrocarbons, and (3) for the analysis of trace amounts of petroleum alkanes in biota, OEP values, n-heptadecane/pristane and n-octadecane/phytane ratios have low utility.

50592 Determination of traces of organic material in aqueous solutions. Russell, E.R. (E.I. duPont de Nemours and Co., Aiken, SC). *Anal. Chim. Acta;* **88**: 171-176(1977).

Trace quantities of organic material in aqueous solution are determined by wet oxidation of the organic material and volumetric measurement of the resulting carbon dioxide. Recovery of CO_2 from standard samples averages >97%. The sensitivity of the method is limited only by a blank determination of 2. 10^{-7} mol per sample. The method has been applied to the measurement of tributyl phosphate (TBP) in equilibrium with water.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 50563, 50570, 50571

50593 Dispersion of plutonium from contaminated pond sediments. Rees, T.F.; Cleveland, J.M.; Gottschall, W.C. (Rockwell International, Golden, CO). *Environ. Sci. Technol.;* **12**: No. 9, 1085-1087(Sep 1978).

Sediment—water distributions of plutonium as a function of pH and contact time were investigated in a holding pond. Although plutonium has been shown to sorb from natural waters onto sediments, the results of this study indicate that under the proper conditions it can be redispersed at pH 9 and above. Concentrations greater than 900 pCi Pu/L result after 34 h contract at pH 11 or 12 and the distribution coefficient, defined as the ratio of concentration in the sediment to that in the liquid, decreases from 1.1 x 10^5 at pH 7 to 1.2 x 10^3 at pH 11. The plutonium is probably dispersed as discrete colloids or as hydrolytic species adsorbed onto colloidal sediment particles whose average size decreases with increasing pH above pH 9. About 5% of the total plutonium is dispersed at pH 12, and the dispersion seems to readsorb on the sediment with time. Consequently, migration of plutonium from the pond should be slow, and it would be difficult to remove this element completely from pond sediment by leaching with high pH solutions.

50594 Erosional removal of fallout plutonium from a large midwestern watershed. Sprugel, D.G.; Bartelt, G.E. (Argonne National Lab., IL). *J. Environ. Qual.;* **7**: No. 2, 175-177(1978).

The Great Miami River at Sidney, Ohio, drains a 1,401-km^2 watershed which is generally flat and predominantly agricultural. Samples of river water collected over a wide range of flow and sediment loading conditions showed that the concentrations of ^{239,240}Pu in filtered water and suspended sediment were fairly constant, with means of 0.15 fCi/liter for water and 14 fCi/g for suspended sediment. Plutonium concentrations in suspended sediment are somewhat higher than plow-layer soil concentrations, probably due to settling of larger soil particles in ponds and backwaters in the upper reaches of the river. Annual plutonium transport from the watershed by erosion averages 1.2 mCi, or 0.9 pCi/m^2, which is about 0.05% of the total plutonium in the watershed soil. The primary mechanism for plutonium removal is erosion of small soil particles to which the element is sorbed.

50595 Erosional transport and deposition of plutonium and cesium in two small midwestern watersheds. Muller, R.N.; Sprugel, D.G.; Kohn, B. (Argonne National Lab, IL). *J. Environ. Qual.;* **7**: No. 2, 171-174(1978).

The soils and sediments of two small watersheds and their retaining ponds were sampled in a study of the erosional transport of plutonium and cesium in midwestern ecosystems. In a watershed

which had been used exclusively for row crops no relationship was observed between plutonium content of the sediments and location of the pond or clay content. In a pasture watershed sorting of the eroded material had occurred prior to entry into the pond and also within the pond. Clay content in the pasture pond sediments was significantly higher than in the soils of the surrounding watershed and increased with increasing distance from the inlet. Plutonium concentration in the sediments was strongly correlated with clay content, reflecting the higher plutonium content of finer soil particles. Cesium behaved similarly to plutonium in the soils and sediments of both watersheds. Where sorting occurs, as in the pasture watershed, deposits of fine sediments will contain higher plutonium and cesium concentrations than in the original surface soil.

WATER

REFER ALSO TO CITATION(S) 49562, 49568

50596 (UCRL—82638(Rev.1)) **Plutonium in the north equatorial Pacific.** Noshkin, V.E.; Wong, K.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 May 1979. Contract W-7405-ENG-48. 21p. (CONF-790382—1). P 02/MF A01.

From Radionuclide/trace element cycling workshop; Gaithersburg, MD, USA (7 Mar 1979).

The concentrations of plutonium in samples collected from the north equatorial region of the Pacific Ocean are presented. The results discussed in this abstract are preliminary, and some of the conclusions and descriptions of results may be revised after results from similar tests made by Woods Hole Oceanographic Institute are critically compared. An early exchange of these data is warranted because the results are directly related to the objectives of the workshop—to assess the processes, behavior, and fate of radionuclides in oceanic environments.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 50583

50597 (EML—356, pp I.59-I.250) **Some measurements of global fallout suggesting charactristics of the N. Pacific controlling dispersal rates of certain surface pollutants.** Folsom, T.R. (Univ. of California, San Diego, La Jolla). 1 Jul 1979.

In Environmental quarterly, March 1—June 1, 1979.

Between 1964 and 1977 eight constituents of nuclear fallout were measured in liver and muscular tissues of albacore that migrate to a fishery region west of California. Using a simple model, factors were identified that appear to have controlled the changes in concentrations of the different nuclides. Using some simplifying assumptions it is shown that the observed behavior of Cs-137 came from characteristics of historical stratospheric fallout, and that the fish responded fast enough to indicate changes in Cs-137 in the upper layers of the sea west of California. It is shown that several chemically different nuclides such as Cs-137, Ag-110m, and Pu-239 persisted for almost equally long periods disappearing by half in about 5 years in the fishery area, however, the Fe-55 disappeared by half in only about one year. Studies of Cs-137 concentrations in upstream surface waters and in shallow subsurface layers suggest that in waters west of California the persistence of a long-lived isotopic tracer most likely is controlled by long distance advections of inputs.

50598 (EML—356, pp I.351-I.379) **Strontium-90 in the diet: results through 1978.** Klusek, C.S. 1 Jul 1979.

In Environmental quarterly, March 1—June 1, 1979.

Estimates of ^{90}Sr intake via the total diet in New York City and San Francisco have been made since 1960 from quarterly food samplings and average consumption statistics. The dietary intakes of ^{90}Sr have decreased from the maximum levels attained during 1963 to 1964, but the declines have become more gradual in recent years due to the continuing small amounts of ^{90}Sr deposition and the little-changing cumulative deposit of ^{90}Sr in the soil. The annual intake in 1978 averaged 7.5 pCi/day in New York and 3.2 pCi/day in San Francisco. Further gradual reductions in ^{90}Sr intake are anticipatd during 1979.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 49854

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 50601

REGULATIONS

REFER ALSO TO CITATION(S) 50169, 50177, 50178, 50179, 50180, 50181, 50182, 50183, 50184, 50185, 50186, 50187, 50188, 50189, 50190, 50191, 50192

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 50149, 50161, 50164, 50280

50599 **Index of harm: a measure for comparing occupational risk across industries.** Solomon, K.A.; Abraham, S.C. Santa Monica, CA; Rand Corp. (1979). 47p. (RAND/R—2409-RC).

This areport explores the implications of an index-of-harm methodology that compares occupational risks among workers exposed to radiological and nonradiological harms. It extends the work of the International Commission on Radiological Protection (ICRP) by considering American rather than European and Japanese industry groups, by treating the relative importance of various occupational harms as a parameter rather than an arbitrary constant, and by identifying several ways in which both the methodology and the data base could be improved. Unfortunately, the data base is too fragmented, and radiological risk estimates are too imprecise for quantitative comparisons across industries. Inclusion of subjective risk preferences is one way to make policy-relevant judgments based on a limited data base. Our study agrees with known accidental fatality rates by showing the riskiest industries to be mining; agriculture, forestry, and fisheries; construction; transportation; and manufacturing - roughly in that order. Using a factor of five times the ICRP dose/risk parameter suggests that the index of harm for radiological workers exposed to 0.35 Rem/yr is still below that of the five riskiest industries. However, the rankings re altered considerably at the regulatory dose level of 5.0 Rem/yr. At that level, the nuclear industry would be significantly more risky, particularly when upper risk estimates are used. (PCS)

ASSESSMENT OF ENERGY TECHNOLOGIES

50600 (DOE/IA—0002/03) **Joint Egypt/United States report on Egypt/United States cooperative energy assessment. Volume 3 of 5 Vols. Annexes 2—5.** (Department of Energy, Washington, DC (USA)). Apr 1979. 368p. P 16/MF A01.

The principal objectives of the energy assessment project for Egypt are to develop understanding of the current status of the principal energy users in Egypt's industrial and agricultural sectors; to estimate the energy demand and efficiency for each selected subsector within these major sectors; to identify opportunities for fuel type changes, technology switches, or production pattern changes which might increase the efficiency with which Egypt's energy is used both now and in the future; and based on options identified, to forecast energy efficiencies for selected Egyptian subsectors for the years 1985 and 2000. The areas studied in the industrial sector are the iron and steel, aluminum, fertilizer, chemical, petrochemical, cement, textile, and automotive manufacturing industries. Those studied in the agricultural sector concern drainage and irrigation, mechanization, and food processing. Additional information in 4 annexes include industrial/agricultural sector options; residential/commercial, transportation, and fossil fuels supply options.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 49570

50601 (DOE/EA—0025) **Environmental assessment: land acquisition and facility construction.** (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Research Center). Mar 1978. 80p. P 05/MF A01.

Bartlesville Energy Research Center (BERC), Bartlesville, Oklahoma, has been faced with major problems in the past over the physical locations of some buildings at the Center. The buildings include a fuel/engine testing laboratory and a site for storing highly flammable petroleum fuels. The proposed solution by the BERC management is to acquire two blocks of land adjacent to the northern boundary and relocate the two problematic facilities at the new site. This action would minimize the high noise levels and fire

hazards to the community by relocating both the fire hazard and the noise source at distances farther from the densely populated areas. Additional precautions are also planned. This report examines the existing baseline data and assesses the associated environmental impacts due to the proposed expansion of the Bartlesville Energy Research Center. No significant long-range environmental impact could be identified.

50602 (NUREG—0583) **Final environmental statement related to the Plateau Resources Limited Shootering Canyon Uranium Project (Garfield County, Utah).** (Nuclear Regulatory Commission, Washington, DC (USA)). Jul 1979. 275p. Q 12/MF A01.

The proposed action is the issuance of a Source Material License to Plateau Resources, Ltd., for the construction and operation of the proposed Shootering Canyon Uranium Project with a product (U_3O_8) production limited to 2.2×10^5 kg (4.9×10^5 lb) per year. Impacts to the area from the operation of the Shootering Canyon Uranium Project will include the following: alterations of up to 140 ha (350 acres) that will be occupied by the mill, mill facilities, borrow areas, tailings areas, and roads; an increase in the existing background radiation levels of the mill area as a result of continuous but small releases of uranium, radium, radon, and other, radioactive materials during construction and operation; socioeconomic effects on the local area, particularly the proposed community of Ticaboo, where the majority of workers will be housed during project construction and operation; and production of solid waste material (tailings) from the mill at a rate of about 680 MT (750 tons) per day and deposition as a slurry in an onsite impoundment area; construction and operation of the Shootering Canyon mill will provide employment and induced economic benefits for the region but may also result in some socioeconomic stress. On the basis of the analysis and evaluation set forth in this Environmental Statement, it is proposed that any license issued for the Shootering Canyon mill should be subject to certain conditions for the protection of the environment. A list is included. Nine appendices are also included. (JGB)

50603 Draft environmental impact statement. Proposed sale of permanent easement for coal-loading barge terminal on Melton Hill Reservoir tracts XMHR-79R and XMHR-80R. Chattanooga, TN; Tennessee Valley Authority (1979). 113p. (NP—23791).

Discussion is presented on the following topics: description of proposed barge terminal project; Melton Hill Reservoir (impoundment and land use planning); site description and environmental impacts (including recreation and aesthetic resources, residential property values, cultural resources, air quality, water quality, and noise); floodplain management and wetlands protection; adverse impacts which cannot be avoided should the project be implemented; relationship between local short-term uses of man's environment and maintenance and enhancement of long-term productivity; irreversible or irretrievable commitments of resources that would result from the proposed action; action benefits; and action alternatives. References and twelve appendixes are also included. (JGB)

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 50633, 50634

50604 Protein synthesis and memory studied with anisomycin. Bennett, E.L. (Univ. of California, Berkeley); Rosenzweig, M.R.; Flood, J.F. pp 319-330 of Mechanisms, regulation, and special function of protein synthesis in the brain. Roberts (ed.). Amsterdam, Netherlands; Elsevier/North-Holland Biomedical Press (1977).

This paper considers a number of aspects of research using inhibitors of protein synthesis to determine the role of such synthesis in formation of long-term memory. The importance of aspects of the behavioral tasks is discussed, and the relative value of anisomycin and other inhibitors is considered. Several alternatives or arguments against the protein-synthesis hypothesis are rebutted. The review indicates that single experiments prove little; parametric research varying systematically such factors as strength of training and magnitude of inhibition, as well as use of appropriate control experiments, is necessary.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 50604, 50607, 50609, 50628

50605 (CONF-790485—1) **^{13}C cross-polarization magic-angle NMR studies of biological systems.** Danyluk, S.S.; Schwartz, H.M. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 26p. P 03/MF A01.

From Stereodynamics of molecular systems symposium; Albany, NY, USA (23 Apr 1979).

The following topics are discussed: use of high-resolution NMR spectroscopy for studies on naturally occurring biological molecules; cross-polarization magic-angle techniques; transfer of magnetic polarization from an abundant magnetic nucleus, ^1H, to a less abundant nucleus, ^{13}C, via the thermal reservoir; high-resolution ^{13}C spectra for membrane constituents of bacterial cells; high-resolution ^{13}C spectra for canine tendon, bovine tendon, and mouse tail, lipid mobilities in various tissue states; comparison of mobility of collagen in canine tendon with that of bovine tendon and rat skin; and measurement of ^{13}C natural abundance spectra for several polycrystalline and amorphous biomolecular materials. (HLW)

50606 Tissue enzyme changes in parabiotic rats with subcutaneous lymphoma or fibrosarcoma. Herzfeld, A.; Greengard, O.; Warren, S. (Harvard Medical School, Boston, MA). Contract EY-76-S-02-3017.A001. *J. Natl. Cancer Inst.;* **60**: No. 4, 825-828(Apr 1978).

A solid lymphoma implanted into normal inbred Kx rats and one partner of parabiotic pairs caused appreciable decreases in hepatic ornithine aminotransferase and arginase about a week earlier (4 to 6 days after implantation) in single hosts than in parabiotic hosts. By 18 to 21 days significant decreases in both enzymes were apparent in the host partner also. The hepatic thymidine kinase showed a five-fold elevation in single hosts 4 days after implantation; by 14 days its levels were about 200 times above normal and had also risen in the parabiotic hosts (20-fold) and host partners (four-fold). Implantation of fibrosarcoma caused qualitatively similar but generally less pronounced changes in these three enzymes in livers of single hosts, parabiotic hosts, and host partners. The splenic thymidine kinase 14 days after implantation was increased from control levels of about 3 U/g to 50.6, 44.8, and 13.5 U/g in single hosts, parabiotic hosts, and host partners, respectively. At later stages, 17 to 20 days after implantation of the lymphoma, appreciable amounts of thymidine kinase appeared in the plasma: The units of activity per milliliter were 6.2 in single hosts, 0.79 in parabiotic hosts, and 0.55 in host partners (control < 0.05). Observations on the changes in hepatic and splenic enzymes in parabiotic rats suggest that effects of neoplasms on distant host tissues are mediated by humoral factors. The less pronounced responses in parabiotic than in single hosts indicate that the tumor-free partner affords some protection against these systemic effects.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 50610

CYTOLOGY

REFER ALSO TO CITATION(S) 50615, 50616, 50630

50607 Measurement of Ca^{2+} effluxes from bone. Neuman, W.F.; Brommage, R.; Myers, C.R. (Univ. of Rochester Medical Center, NY). *Calcif. Tissue Res.;* **24**: 113-117(1977).

To facilitate the study of membrane function in the control of the flow of ions into and out of bone, it was desirable to develop a system for the direct quantitation of unidirectional effluxes of calcium and phosphate from bones. Based on a mathematical analysis of the problem, a specially designed Ussing chamber was developed which proved successful. Calvaria from 2-day-old rat pups, 3-day chicks and adult mice were evaluated. Calcium influxes which exceeded the corresponding effluxes were observed in the neonatal calvaria but not with those from adult mice. Also, an asymmetry in efflux was observed in rat calvaria, the inner side of the skull showed a higher efflux than did the external side. No such asymmetry was seen with calvaria from chicks or mice. This new technology should permit a further exploration of the role of the bone membrane in electrolyte homeostasis.

50608 Chamber attached to the SEM for fracturing and coating frozen biological samples. Pawley, J.B. (Univ. of California, Berkeley); Norton, J.T. *J. Microsc. (Oxford);* **112**: 169-182(Mar 1978).

A chamber for introducing, fracturing and coating frozen biological samples has been developed as an attachment to the specimen chamber of a scanning electron microscope. Together with a eucentric-tilt cold-stage, this chamber constitutes a complete system for viewing fractured biological surfaces of the type normally only seen by replica techniques. An air-lock on the chamber accepts a transfer module to allow insertion of the frozen sample without frost build-up. Fracturing is carried out with a precisely adjustable cooled knife under a 10-100x binocular microscope. The sample can tilt and rotate while being coated with carbon or metals evaporated

from recharageable sources introduced through the air lock. Cooling in the chamber is provided by a cylindrical copper tank filled with liquid nitrogen. The chamber has its own LN_2 trapped high vacuum system. After preparation the sample can be placed directly into the SEM through an isolation valve. The cold-stage utilizes a Joule—Thomson refrigerator. The sample can be kept below 103 K at all times though there are provisions for heating it in the fracturing and cold-stage positions. A system of controls, sensors and interlocks simplifies the operation of the system.

GENETICS

50609 Human inherited diseases with altered mechanisms for DNA repair and mutagenesis. Cleaver, J.E. (Univ. of California, San Francisco). Contract AT(04-3)-1012-386. *Excerpta Med. Int. Congr. Ser.;* No. 432, 85-100(1977).

From 5. international conference; Montreal, Canada (21 Aug 1977).

A variety of human diseases involving clinical symptoms of increased cancer risk, and disorders of the central nervous system, and of hematopoietic, immunological, ocular, and cutaneous tissues and embryological development have defects in biochemical pathways for excision repair of damaged DNA. Excision repair has multiple branches by which damaged nucleotides, bases, and cross-links are excised and requires cofactors that control the access of repair enzymes to damage in DNA in chromatin. Diseases in which repair defects are a consistent feature of their biochemistry include xeroderma pigmentosum, ataxia telangiectasia and Fanconi's anemia.

METABOLISM

REFER ALSO TO CITATION(S) 50628

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 50617

MEDICINE

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 50424

50610 (UCLA—12-1162) **Measurement of regional cerebral metabolic rate for glucose in the human subject with (F-18)-2-deoxy-2-fluoro-d-glucose and emission computed tomography: validation of the method.** Phelps, M.E.; Huang, S.C.; Hoffman, E.J.; Selin, C.; Kuhl, D.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 51p. (CONF-7706182—1). P 04/MF A01.

From 8. cerebral blood flow symposium; Copenhagen, Denmark (27 Jun 1977).

Tracer techniques and models of in vitro quantitative autoradiography and tissue counting for the measure of regional metabolic rates (rMR) are combined with emission computed tomography (ECT). This approach, Physiologic Tomography (PT), provides atraumatic and analytical measurements of rMR. PT is exemplified with the regional measurement of the cerebral metabolic rate for glucose (CMRGlu) in man with (^{18}F)-2-deoxy-2-fluoro-D-glucose (FDG) and positron ECT. Our model incorporates a k_4* mediated hydrolysis of FDG-6-PO_4 to FDG which then competes with phosphorylation (k_3*) of FDG back to FDG-6-PO_4 and reverse transport (k_3*) back to blood. Although small, k_4* is found to be significant. The ECAT positron tomograph was used to measure the rate constants (k_1*→k_4*), lumped constant (LC), stability, and reproducibility of the model in man. Since these parameters have not been measured for FDG in any species, comparisons are made to values for DG in rat and monkey. Compartmental concentrations of FDG and FDG-6-PO_4 were determined and show that cerebral FDG-6-PO_4 steadily accumulates for about 100 mins, plateaus and then slowly decreases due to hydrolysis. Cerebral blood FDG concentration was determined to be a minor contribution to tissue activity after 10 min. Regional CMRGlu measurements are reproducible to +- 5.5% over 5 hrs. PT allows the in vivo study ofregional biochemistry and physiology in normal and pathophysiologic states in man with a unique and fundamental capability.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 49665, 49672, 49673, 49674, 49680, 49690

MORPHOLOGY

REFER ALSO TO CITATION(S) 50631

PATHOLOGY

REFER ALSO TO CITATION(S) 50606, 50609

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 50607, 50632, 50633

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 50610

BIOMEDICAL SCIENCES, APPLIED STUDIES

50611 (JPRS—73387) **Translations on USSR science and technology. Biomedical and Behavioral Sciences, No. 63.** 4 May 1979. Translation of various articles. 56p. C .

The report contains information on aerospace medicine, agrotechnology, bionics and bioacoustics, biochemistry, biophysics, environmental and ecological problems, food technology, microbiology, epidemiology and immunology, marine biology, military medicine, physiology, public health, toxicology, radiobiology, veterinary medicine, behavioral science, human engineering, psychology, psychiatry and related fields, and scientists and scientific organizations in biomedical fields.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

50612 Oxygen enhancement ratio for negative pi mesons. Hall, E.J.; Astor, M. (Columbia Univ., New York, NY). Contract EP-78-S-02-4733. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 1, 55-60(Jan 1979).

Experiments were performed at the Los Alamos Meson Physics Facility (LAMPF) to determine the oxygen enhancement ratio (OER) for the clinically used beam of negative pi mesons. V79 Chinese hamster cells, cultured in vitro, were used as the biological test system; hypoxia was produced by metabolic depletion as a result of sealing 2 million cells in 1 ml glass ampules. The Bragg peak of the pion depth dose curve was spread out to cover 10 cm by using a dynamic range shifter. Cells were irradiated at the center of the spead out Bragg peak, where the dose/rate was 0.1 Gy/min over a 6 x 6 cm field. The OER obtained was 2.2, compared with 3.8 obtained for γ rays under the same conditions.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 50572, 50599

50613 (CONF-781181—1) **Development of a mid-head tissue dose response function.** Trubey, D.K.; Bartine, D.E.; Pace, J.V., III; Knight, J.R. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 4p. P 02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1978).

The technique used in this investigation was to calculate the radiation transport in a two-dimensional adjoint model by the discrete ordinates code DOT 3.5. An S_8P_3 approximation was used. The adjoint source was taken to be the tissue kerma response in a 1-cm-radius region in the center of the head. The procedure was to then calculate in the adjoint mode the current on the surface of the phantom model. The adjoint leakage gives the response function for scoring an isotropic incident radiation field, and the exit adjoint angular flux gives the response for angular-dependent incident radiation. The head models employed were basically those suggested by Warshawsky for use in correlating radiation dose received in monkeys during experiments at the Armed Forces Radiological Research Institute with personnel dose received in a nuclear weapons environment.

VERTEBRATES

REFER ALSO TO CITATION(S) 50614

MAN

REFER ALSO TO CITATION(S) 50598, 50614

ANIMALS

REFER ALSO TO CITATION(S) 50597

CHEMICALS METABOLISM AND TOXICITY

CELLS

50614 (LA—7254-PR) **Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January—December 1977.** Petersen, D.F.; Sullivan, E.M. (comps.). (Los Alamos Scientific Lab., NM (USA)). Oct 1978. Contract W-7405-ENG-36. 201p. P 10/MF A01.

The report summarizes research and development activities of LASL's Biomedical and Environmental Research Program for the calendar year 1977. The principal features of the program have been carried out by groups in the Health Division, supported by the Assistant Secretary for the Environment of the United States Department of Energy. Previous annual reports in this series prepared under the auspices of the United States Atomic Energy Commission and the United States Energy Research and Development Administration are LA-4923-PR (1971), LA-5227-PR (1972), LA-5633-PR (1973), LA-5883-PR (1974), LA-6313-PR (1975), and LA-6898-PR (1976). Technical information related to the current status of projects in the major program areas of each contributing group is presented in sufficient detail to permit the informed reader to assess scope and significance and to obtain specific information from the publications listed in Appendix A. Summaries useful to the casual reader desiring general information have been prepared by the Group Leaders and appear at the beginning of each section of the report. Separate entries were made for various sections of the report.

50615 Toxicity and carcinogenicity of benzo(a)pyrene in cultured lung cells and tracheal segments of the Syrian hamster fetus. Development and first experiences with an in-vitro test system. Richter-Reichhelm, H.B.; Emura, M. (Medizinische Hochschule Hannover, Germany). *Staub-Reinhalt. Luft;* **38**: No. 6, 247-250(Jun 1978). (In German).

Mixed lung-cell cultures from fetal Syrian golden hamsters were treated with 0 to 5 μg/ml of benzo(a)pyrene (BAP). A dose-dependent toxicity was detected with the colony-forming assay. The addition of insulin improved the plating efficiency. The rate of transformation among fibroblastic cells was also determined. The soft agar test was performed to detect the transformation of epi- and endothelial-like cells, which were cloned from mixed lung-cell cultures. Four out of the six cell lines showed a colony-forming ability. Within three months, four of the five syngenic newborns subcutaneously injected with in-vitro transformed epi- and endothelial-like cells developed sarcomas. The histological evaluation of the BAP-treated in-vitro explants of trachea from the same fetuses is still in progress. So far, about 15% of the treated explants have shown squamous cell metaplasia and other epithelial alterations.

50616 Inhibitory and toxic effects of methylmercuric chloride on the cell cycle of cultured mammalian cells. Sheck, L.E.H. Rochester, NY; Univ. of Rochester (1978). 252p. L 78-20,005.

Thesis (Ph. D.).

The effects of methylmercuric chloride (MeHgCl) on the cell cycle were investigated in mouse leukemic cells (L5178Y) grown in suspension culture and HeLa M cells grown in monolayer. Population growth, cell division, reproductive integrity and viability were monitored as a function of concentration during acute and prolonged exposures. During initial exposure, L5178Y cells exhibited a decrease in growth rate before division in a dose-dependent manner. Cells treated with 0.5 to 1.0 μM suggested G_2 and M phase were effected. A more sensitive site located in late S phase was indicated at 0.3 μM, characterized by (1) a 4 h period of near normal cell growth between exposure and inhibition; (2) parasynchrony when resuspended in control medium after 9 h of exposure; and (3) a delay in the second mitotic burst of synchronized cells 4 h before mitosis. Autoradiographic analysis of distribution in each stage showed an accumulation of S phase cells in asynchronous cultures during the first 7.5 h of exposure. Initial population doubling time was attributed to a 66% lengthening of the S phase. DNA synthesis was reduced to 58%. Prolonged exposure of L5178Y cells showed a dose-dependent recovery from the initial decrease. Exponential growth was caused by the lengthening of 1 or more phases. S phase was prolonged by 0.3 μm, while S and M phases were prolonged by 0.5 μM. Synchronized cells exposed to ≧ 1.0 μM showed (1) cell damage was cumulative and (2) all phases were sensitive while M phase was initially sensitive. In ancillary studies, HeLa M cells were found to be 3 times more resistant than L5178Y cells by survival curve analysis.

PLANTS

REFER ALSO TO CITATION(S) 50578

50617 (BNL—26259) **Subcellular site and nature of intracellular cadmium in plants.** Wagner, G.J. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 24p. (CONF-790673—1). P 02/MF A01.

From 13. annual conference on trace substances in environmental health; Columbia, MO, USA (4 Jun 1979).

The mechanisms underlying heavy metal accumulation, toxicity and tolerance in higher plants are poorly understood. Since subcellular processes are undoubtedly involved in all these phenomena, it is of interest to study the extent of subcellular site of and nature of intracellularly accumulated cadmium in higher plants. Whole plants supplied $^{109}CdCl_2$ or $^{112}CdSO_4$ accumulated Cd into roots and aerial tissues. Preparation of protoplasts from aerial tissue followed by subcellular fractionation of the protoplasts to obtain intact vacuoles, chloroplasts and cytosol revealed the presence of Cd in the cytosol but not in vacuoles or chloroplasts. Particulate materials containing other cell components were also labeled. Of the ^{109}Cd supplied to plants, 2 to 10% was recovered in both cytosol preparations and in particulate materials. Cytosol contained proteinaceous—Cd complexes, free metal and low molecular weight Cd complexes. Labeling of protoplasts gave similar results. No evidence was obtained for the production of volatile Cd complexes in tobacco.

50618 Response of vegetable crops to acid rain under field and simulated conditions. Mohamed, M.B. Ithaca, NY; Cornell Univ. (1978). 171p. L 79-02,351.

Thesis (Ph. D.).

The effect of acid rain on vegetable plant life was studied during 2 growing seasons in Ithaca, NY. The lowest level was pH 3.7; the highest was pH 4.55. The rain appears to remove sulfur dioxide and nitrogen dioxide pollutants since rain collected early in a continuous rainy season had a lower pH than that at the end. Field plants were grown with and without plastic shields. Of the 17 types grown, 4 showed no differences, and those affected improved with an increase in pH. Seed germination was not affected. Early growth showed damage but improved with an increase in pH. Simulated rainfall at pH 3.0 for 1 h/day for 1 week caused morphological injury and reduced growth; at pH 4.0, the amount of injury decreased; at pH 5.6 there was no injury but growth rate diminshed. Sweet corn was the least affected by acid rain and tomatoes were the most affected of those tested. The duration of rainfall was directly proportional to the amount of injury to the plant. Plants at different leaf developmental stages were treated with simulated rainfall at pH 3.0. Leaf stage was not significant in determining the amount of injury to the plant or its growth when exposed to acid rain. There was a cumulative effect of acid rainfall at the lowest pH. The yield, related to market acceptability, was adversely affected by the natural acid rain. When tested in the greenhouse, with simulated rain, then transplanted in the field, crops were affected by pH 3.0 but improved with increase in pH.

50619 Growth impact of O_3, SO_2, and NO_2 singly and in combination on loblolly pine (Pinus taeda L.) and American sycamore (Platanus occidentalis L.). Kress, L.W. Blacksburg, VA; Virginia Polytechnic Institute and State University (1978). 220p. L 79-01,775.

Thesis (Ph. D.).

Several full-sib families of loblolly pine and half-sib families of American sycamore were screened for sensitivity to O_3, NO_2, or SO_2. A sensitive and a tolerant family of each species was selected to study the effects of exposures with 5 pphm O_3, 10 pphm NO_2, and 14 pphm SO_2 singly and in combination. Two families of loblolly pine were used to determine the effects of ambient Radford Army Ammunition Plant (RAAP) air. One to two week old trees were exposed 6 hours per day for 28 or 56 consecutive days. Significant height growth suppressions were noted in the sensitive family of both species in all treatments except NO_2 alone for pine and both the NO_2 alone and the O_3 + NO_2 for sycamore. Ozone + SO_2 had more effect than either alone, and adding NO_2 further suppressed the height growth. Height growth suppressions were noted for the tolerant family of both species only in combination treatments. Adding NO_2 to the O_3 + SO_2 further suppressed height growth in tolerant sycamores but not in tolerant pines. The sensitive sycamores exhibited greater height growth suppressions, 45% versus 34% for the tolerant sycamores. The sensitive pines suffered 30% height growth suppression versus 14% for the tolerant pines. Foliar injury was not evident on the sycamores nor exceeded 5% on the pines. Trees exposed to ambient air at RAAP were in open-top chambers. At three sites the treatments were charcoal-filtered air, non-filtered air, and open plots for the entire 1977 growing season. The sensitive pine family exhibited 40% height growth suppression in non-filtered

air, with no foliar symptoms. The tolerant pine family exhibited 29% growth suppression in non-filtered versus filtered air. The sensitive family was taller than the tolerant family in filtered air, but smaller in non-filtered air. Selected families of loblolly pine and American sycamore may be used as bioindicators of ambient air pollution.

50620 Effects on cadmium, zinc, lead and molybdenum on germination and growth of selected grasses. Rothenberger, S.J. Fargo, ND; North Dakota State Univ. (1978). 152p. L 79-02,474.
Thesis (Ph. D.).

Growth chamber and greenhouse studies were conducted to assess the possible impact of heavy metals from coal-fired power plant emissions on dominant vegetation types in west—central North Dakota. Treatments of the heavy metals, Zn, Cd, Pb, and Mo in concentrations from 1 to 1000 ppM affected germination, root elongation, shoot growth, and dry matter production of the following grasses: wheat (Triticum aestivum L.), barley (Hordeum vulgare L.), western wheatgrass (Agropyron smithii Rydb.), blue grama (Bouteloua gracilis (H.K.B.) Lag. ex Steud., switchgrass (Panicum virgatum L.), and green needlegrass (Stipa viridula Trin.). Seed germination of all 6 species was significantly reduced by treatments of Cd (as $CdCl_2$) solution at a concentration of 1000 ppM. Shoot and root growth of switchgrass, the most sensitive species, was reduced by concentration of Cd as little as 1 ppM. Although no effects of toxicity were observed in plants grown in vermiculite treated with metal solutions applied foliarly, metal solutions applied topically reduced shoot growth of the test species and were toxic in the order of: Cd > Mo > Zn > Pb. Salts of Cd and Zn preincorporated into soil prior to planting resulted in acute chlorosis, stunted shoot growth, and reduced dry matter production (as high as 90%) in wheat and barley. In vivo nitrate reductase activity and protein content in barley were reduced 56% and 26%, respectively, by treatments of 1000 ppM Cd (as $CdCl_2$) indicating that treatments affected protein synthesis and/or enzyne activity. Decreased transpiration rates in wheat and barley treated with Cd or Mo at concentrations of 10 to 1000 ppM were possibly a result of root damage followed by a subsequent decline in water absorption.

50621 Grassland sulfur cycle and ecosystem responses to low-level SO_2. Coughenour, M.B. Fort Collins, CO; Colorado State Univ. (1978). 370p. L 78-20,847.
Thesis (Ph. D.).

A systems approach was taken to investigate the consequences of sulfur dioxide removal from the atmosphere by a mixed-grass prairie typical of much of the northern Great Plains. The deposition of SO_2, the assimilation of CO_2, the distribution of this sulfur and carbon by primary producers, and the effect of continuous 10 pphM SO_2 exposure on these processes were investigated in a ^{35}S—^{14}C tracer study. The percentage of carbon sent belowground decreased from 51% in May and 57% in July to 22% in September. The proportion sent to shallow roots decreased, while that sent to deeper roots increased throughout the season. Sulfur dioxide was deposited in significant quantities onto live and dead leaf surfaces and litter and was assimilated through the stomates and translocated to roots. Chronic exposure to 10 pphM SO_2 seemed to enhance root growth at 5 to 20 cm in July and to weaken the soil—plant relationship with respect to sulfur nutrition. Simulation modeling was used to investigate the interaction of SO_2—sulfur with the sulfur cycle. This approach revealed a total addition of sulfur to the system of 48.2 kg $S.ha^{-1}.yr^{-1}$ at 10 pphM. The sum of all system flows of sulfur was increased by 3.2 to 5.8 g $S.m^{-2}$ over each of two growing seasons. Sulfur was also reapportioned among individual sulfur state variables in 4 to 9 times greater quantities under fumigation. Simulation modeling also showed the potential for a plant response to this form of sulfur fertilization and demonstrated that if aboveground growth is stimulated more than is net photosynthesis, a decrease in belowground growth may be observed. Combining an increase in senescence rate with a change in allocation of photosynthate among rooting depths could produce an overall negative effect on peak standing crop, which may effectively cancel the positive effects of fertilization.

50622 Cadmium—ozone interactions in cress, tomato, and bean in relation to phytotoxicity, growth, and mineral and water contents. Czuba, M. Guelph, Ontario; Univ. of Guelph (1978). vp. National Library of Canada, Ottawa.
Thesis (Ph. D.).

Plants were grown for 4 weeks under controlled conditions. The studies involved comparisons of Cd and O_3 in factorial combinations, species variability, Cd forms, Zn or Ca countertreatments and comparisons of plant parts before, during and after O_3 exposure. Cd added to the rooting medium decreased water and pigment contents and increased injury after O_3 exposure compared with Cd or O_3 alone. Chlorophyll b content decreased more than chlorophyll a or carotenoids in cress and lettuce. Red pigments induced by Cd in cress were bleached after O_3 exposure. Shoot and root fresh weight, dry weight, root length, leaf number and flower bud development were decreased at high Cd—O_3 concentrations, but root length and leaf number were increased at low Cd—O_3 concentrations. Older leaves were injured more severely than younger leaves after O_3 exposure. Some measurements suggested an O_3-induced stimulation of Cd uptake in younger parts of the plant. Studies suggested the existence of a critical balance between Ca, Cd, and H_2O in leaves and stems which determined plant sensitivity to O_3 injury. The decreasing magnitude of Cd—O_3 injury among species (cress > tomato > bean) was directly related to frequency of low, medium, or high Ca:Cd ratios in old and young stems as well as Cd or Ca concentrations in plant parts. Zn failed to counteract Cd, O_3, or Cd—O_3 phytotoxicity. The mechanism of Cd—O_3 interaction probably involved a critical relationship between Ca, Cd, and possibly other ions and water in tissues to membrane permeability. Species variability was related to inherent differences in water: cation balance which influenced stomatal function and tissue sensitivity to Cd—O_3 treatment.

50623 Ozone—sulfur dioxide effects on petunia: effects of ozone and sulfur dioxide singly and in combination on Petunia hybrida Vilm. cultivars of differing sensitivities. Elkiey, T.M. Montreal, Quebec; McGill Univ. (1978). vp. National Library of Canada, Ottawa.
Thesis (Ph. D.).

Petunia hybrida Vilm. as an ornamental plant continues to be the species most commonly used as urban bedding plants. Three cultivars: Capri (resistant) Ca(R); White Magic (intermediate) WM(I), and White Cascade (sensitive) WC(S) were exposed to controlled environmental conditions to acute concentrations of 40 pphM O_3 and/or 80 pphM SO_2 in most of these experiments in order to investigate: (1) the response of the three cultivars to O_3 and SO_2 singly and in mixture; and (2) the mechanism(s) of resistance of certain cultivars to O_3 and/or SO_2 injury effects. The O_3 injury was enhanced by SO_2 treatment and resulted in a greater than additive effect in the form of more injury symptoms. The resistance cannot be explained on the basis of differences in stomatal size or number or stomatal diffusive resistance (SRD) since these measurements were found to be about equal in the three cultivars. The mixture of O_3 + SO_2 caused an increase in SRD somewhat similar to that caused by O_3 alone but was more rapid. No significant difference was found between the leaf water potential of Ca(R) and WC(S). The only significant effect on the cell permeability (K^+ and electrolytes leakage) was caused by O_3 and SO_2 on WC(S). There was no distinct connection between SO_4^{-2} accumulation and either leaf age or plant sensitivity. The relationship between O_3 absorption and exposure period, leaf and plant age and O_3 concentration was also investigated. Ozone and SO_2 were found to inhibit the absorption of each other when mixed together. The effect of increasing RH was obvious in the form of increasing injury, prevention of stomatal closure and enhanced SO_4 accumulation in the leaves.

50624 Sulfur dioxide inhibition of apparent photosynthesis in eastern white pine (Pinus strobus L.). Gall, W.R. Knoxville, TN; Univ. of Tennessee (1978). 124p. L 79-03,419.
Thesis (Ph. D.).

Sulfur dioxide was applied at 0.50, 1.00, 1.50, and 2.00 ppM for one hour to eastern white pine (Pinus strobus L.) seedlings grown from seed collected in Tellico Ranger District of Cherokee National Forest. Seedlings exposed to 1 ppM or higher SO_2 reached zero level CO_2 uptake rate within one hour. SO_2 inhibited net CO_2 uptake rate in the light during fumigation; the same dosages had no effect on dark respiration. It was inferred that light is required for the response observed. Inhibition of CO_2 uptake was found to be a function of SO_2 concentration. SO_2 uptake rates were also inhibited during fumigation; inhibition of CO_2 and SO_2 uptake were significntly correlated ($r = 0.72^*$). Seedlings which had high unfumigated CO_2 uptake rates had higher rates of decline in CO_2 uptake during fumigation. Stomatal closure is a possible mechanism for SO_2 inhibition of white pine CO_2 uptake. Ten half-sib families of the same provenance were fumigated with 0.5 ppM SO_2 for 30 minutes. Among-family variation in CO_2 uptake rate before fumigation was significant at the 10% level, as was among-family variation in percent reduction of CO_2 uptake rate during fumigation.

50625 Effects of cadmium and other heavy metals on native plant species: experimentation and modeling. Miles, L.J. Lafayette, IN; Purdue Univ. (1978). 247p. L 78-21,475.
Thesis (Ph. D.).

Seven plant species native to an urban site in northwestern Indiana with moderate soil heavy metal concentrations were grown from seed in several greenhouse experiments. Soil from this site and a similar soil from an uncontaminated rural site was used as the substrate for these experiments. Cd, Zn, Pb, and Cu averaged 2.32, 442.5, 78.5, and 16.9 ppM, respectively, for the urban potting soil, and 0.33, 16.3, 6.7, and 1.6 ppM, respectively, for the rural potting soil. Germination and survival of all plants grown in the urban and rural soils without additional heavy metals added did not differ significantly. Growth, however, was stunted on the urban soil, which was not overcome completely by the addition of nitrogen, phosphorus, or potassium. Germination, survival, height growth, and dry weight were reduced with addition of Cd ($CdCl_2$) to the rural soil. The effect on plant growth was to delay growth. Soil-

added lead ($PbCl_2$) produced results similar to those for soil-added cadmium but the growth rate was not reduced. Soil-added zinc ($ZnCO_3$) and soil-added copper ($CuSO_4$) gave results similar to those found on the urban soil. Soil samples from pot studies were extracted with DTPA and analyzed for Cd, Zn, Pb, and Cu concentrations. Heavy metal concentrations were well correlated with heavy metal growth effects and plant concentrations for each soil, but were not well correlated for comparisons between the two soils.

50626 Effects of heavy metals on the abundance of aquatic insects and terrestrial plants. Boulay, E.A. Jr. University Park, PA; Pennsylvania State Univ. (1978). 138p. L 79-02,580.

Thesis (Ph. D.).

A study was performed on the effect of heavy metals caused by emissions from smoke stacks of the New Jersey Zinc Company smelter on the abundance of aquatic insects and terrestrial plants during the summers of 1974 and 1975 in Carbon County, Pennsylvania. Measurements of water temperature, stream pH, total acidity and alkalinity, dissolved oxygen, specific conductance and heavy metal content were taken as well as the soil content of heavy metals. Sampling of insect fauna and plant flora was done to determine abundance. All results were within established standards except for heavy metals (mainly zinc). Overall insect population abundances were increased and correlated with increase of heavy metals; while other orders of insects decreased with no correlation. Overall live tree abundance decreased with increasing heavy metal concentrations with the exception of the anthophyte and conifer tree abundance. Sasssafras albidum greatly increased with elevated concentrations of heavy metals, while all seedling abundance decreased with no significant correlation to air pollution levels. There was no correlation in shrub abundance with elevated air pollution, but there was a marked decrease in dicots with increased concentrations of heavy metals. Overall herb abundance also showed the same pattern. The opposite effect was shown in shrubs. The study showed that while heavy metals have adverse effects on insect and plant abundance, some organisms which are tolerant flourish in the more polluted environments.

50627 (IS-M—205) **Trace element levels in native vegetation as a measure of aerosol deposition.** O'Toole, J.J.; Wessels, T.E.; Malaby, K.L. (Ames Lab., IA (USA)). [nd]. Contract W-7405-ENG-82. 4p. P 02/MF A01.

As part of an environmental assessment program, extensive analysis for over thirty elements was completed in five species of native flora in the Fort Union Basin of eastern Montana. Levels of trace elements in foliage collected at the beginning and end of the growing season has provided data on their rates of change during this period. Elements deposited on leaf surfaces from soil and anthropogenic sources have been evaluated as they relate to time, site location and trace element source. Through changes observed in trace element ratios, the sources of root uptake and aerial deposition can be distinguished.

INVERTEBRATES

REFER ALSO TO CITATION(S) 50626

VERTEBRATES

REFER ALSO TO CITATION(S) 50614

50628 Cadmium-induced alteration in hepatic microsomal drug metabolism: sex-related differences in the rat. Pence, D.J.H. Lafayette, IN; Purdue Univ. (1978). 197p. L 78-21,485.

Thesis (Ph. D.).

Three days after a single dose of cadmium (2 mg/kg, i.p.) male, but not female, rats exhibited a potentiation in hexobarbital hypnosis and an inhibition in rates of in vitro hepatic metabolism of hexobarbital and ethylmorphine (type I-androgen dependent substrates). Males and females exhibited potentiated zoxazolamine paralysis and decreased rates of in vitro metabolism of zoxazolamine and aniline (types I and II-androgen independent substrates, respectively). In vivo cadmium treatment decreased the level of cytochrome P-450 and the spectral binding of hexobarbital, ethylmorphine and aniline in microsomes from male rats. Cytochrome b_5 content was not affected. Addition of cadmium to microsomes inhibited hexobarbital and ethylmorphine metabolism only in male-derived microsomes while inhibition of aniline metabolism was found in both sexes. In vitro addition of cadmium also decreased the level of cytochrome P-450 in male rats but only high cadmium concentrations reduced level in females. Binding spectra were reduced for aniline and hexobarbital in male rats. Hexobarbital, ethylmorphine or aniline binding was not reduced in female rats. Administration of cadmium to castrated male rats potentiated hexobarbital hypnosis less and inhibited hexobarbital metabolism less than in sham-operated rats. Treatment of intact as well as castrated male rats with testosterone offered only partial protection against the inhibitory effects of cadmium. Female rats receiving testosterone exhibited induced rates of hexobarbital, ethylmorphine and aniline metabolism which were not susceptible to cadmium inhibition.

50629 Effects of sublethal hexavalent chromium exposure on the osmoregulation, immune response, and blood characteristics of coho salmon (Oncorhynchus kisutch). Sugatt, R.H. Durham, NH; Univ. of New Hampshire (1978). 86p. L 78-20,462.

Thesis (Ph. D.).

A potential field situation in which seaward migrating coho salmon pass through Cr^{+6} polluted fresh water (FW) before being exposed to seawater (SW) or marine pathogenic bacteria was investigated to determine the effects on salinity tolerance, serum osmolality and disease resistance against Vibrio anguillarum. Also studied was the effect of sublethal FW Cr^{+6} exposure on 12 blood characteristics and the sensitivity of blood tests as indicators of toxicity. SW survival decreased in salmon exposed in FW to 0.23 mg Cr^{+6}/l for 4 weeks or to 0.5 mg Cr^{+6}/l for 2 weeks and transferred to 20 or 30% SW, respectively. Serum osmolality after 2 weeks of FW exposure to 0.0 or 0.5 mg Cr^{+6}/l and after transfer to 20 or 30% SW was higher from 1/2 to 2 days after SW transfer, but not at the end of the FW period or at 7 days after SW transfer. Disease mortality to doses of V. anguillarum (ca. 3 to 4 x 10^{2-5} bacteria/.1 ml) increased with dose. Serum agglutinin titers of fish injected with the bacteria and exposed in FW to 0.0 or 0.5 mg Cr^{+6}/l for 2 weeks were undetectable; at 4 weeks, they were equal to control group; at 6 weeks, they were higher in the control group. After 1 week in 1.0 mg Cr^{+6}l FW, hematocrit (HC), methemoglobin (M-Hb), percent M-Hb (% M-Hb), serum total protein (TP), and glucose were higher. Mean corpuscular hemoglobin concentration (MCHC) and erythrocyte sedimentation rate (ESR) were decreased. There was no effect on hemoglobin (Hb), erythrocyte osmotic fragility (EOF), serum osmolality (Os) and serum lysozyme (Lys). Order of significant changes was: M-Hb > % M-Hb > ESR > HC > TP > MCHC > Glu. The results indicate that short term exposure to 0.23 to 1.0 mg Cr^{+6}/l cause a sublethal general stress response and lower disease resistance after SW transfer.

50630 In vivo study of cadmium-induced chromosomal changes in somatic and germinal tissues of C57Bl/6J male mice. Felten, T.L. Corvallis, OR; Oregon State Univ. (1978). 102p. L 78-02,498.

Thesis (Ph. D.).

The in vivo mutagenic potential of cadmium chloride was evaluated by chromosomal examination of bone marrow cells and spermatocytes of C57Bl/6J mice. Cadmium was administered to the mice in single injections of 0.0252, 0.0126, 0.0055 or 0.0 mmoles/kg body weight followed by sacrifice at 6, 24, or 48 hours. Other mice were given a subacute exposure with the same doses split into five injections administered at 24 hr intervals and sacrificed 6 hr after the last injection. An extended duration of acute exposure (30 days) experiment was carried out with doses of 0.0252 and 0.0 mmoles cadmium/kg body weight. In bone marrow cells of acutely exposed mice, chromatid breaks and deletions increased in frequency within 6 hr. After subacute exposure breaks, deletion and despiralizations increased in frequency. With extended acute exposure, rearrangement and pulverization were noted in addition to breaks and despiralization. Spermatocytes of mice exposed to 0.0252 mmole cadmium/kg had increased frequency of achromatic gaps, breaks, autosomal univalents and stickiness. Positive correlation of gaps and breaks from bone marrow and spermatocytes were noted while negative correlations for rearrangements and stickiness were found. Bone narrow cells consistently had more aberrations than spermatocytes. Organ weight/body weight ratios and histologic examination of liver, kidney, spleen and testis revealed severe damage to the liver within 24 hr which persisted through day 30. The spleen responded with proliferation of white pulp by day 3 which persisted through day 30. Assessment of bone marrow response to cadmium by differential leucocyte, reticulocytes and total bone marrow cell counts revealed erythropoietic stress with no marked influence on the white cell population.

50631 Light and electron microscopy determination of the neuropathological effects of cadmium following prenatal exposure. Rohrer, S.R. Lafayette, IN; Purdue Univ. (1978). 114p. L 78-21,493.

Thesis (Ph. D.).

The neuropathological effects of cadmium (Cd) in the fetal rat central nervous system (CNS) was studied following prenatal exposure. Both light and electron microscopy were used. The fetotoxic effect of maternal Cd was also studied. Doses of 0.5, 1.0, or 2.0 mg/kg as cadmium acetate was administered interperitoneally to maternal rats on day 12, 14, 18, or 20 of gestation. Fetuses were sacrificed at various times up to 2 days after birth and the brains, both fetal and neonatal, were examined. No gross malformations were observed from any gestational group regardless of dose, although embryos from rats receiving 1.0 or 2.0 mg/kg of Cd weighed less. Fetal mortality of 100% was observed in the 2.0 mg/kg of Cd treated 20 day rats allowed to give birth. No morphological changes were found in the tissues of any animals studied. Electron microscopic examination showed no ultrastructural changes in neuronal cells. A 2.0 mg/kg dose given on day 20 and sacrificed on day 21

caused the formation of vacuoles in endothelial cells of capillaries in the fetal brains. The same dose given at day 18 did not produce this effect, nor did lower doses on day 20. The vacuoles appear to be the only observable pathological effect of Cd on the endothelial cells. The vacuoles are described, but the mechanism or consequences in the cells or capillaries is unknown.

50632 Mechanical properties of the non-human primate (M. radiata and M. mulatta) respiratory system: including the pathophysiological effects of short-term and long-term exposure to low-level ozone. Kosch, P.C. Davis, CA; Univ. of California (1977). 142p. L 78-03,618.

Thesis (Ph. D.).

Lung volumes and quasi-static volume—pressure curves of lung and chest wall were measured in 22 bonnet (Macaca radiata) and 12 rhesus (M. mulatta) monkeys. Expiratory flow-volume curves and total pulmonary resistance were measured in 15 bonnet and 8 rhesus monkeys. In comparison with interspecies pulmonary function/body weight regressions, monkey lung volumes are larger and considerably more compliant, but chest wall compliance is similar to a wide range of mammalian species. However, chest wall compliance was considerably less than that of other experimental animals such as the dog, cat and rodents. The configuration of maximum expiratory flow-volume curves of both species of monkey, particularly the bonnet, are very similar to those of normal young adult humans. Peak expiratory flow of monkeys was higher than that reported for the average size human. Resistance measurements suggest large and small airways are larger in bonnet than in rhesus monkeys. Measurements indicate that the static and dynamic mechanical properties of the respiratory system of bonnet and rhesus monkeys compare better to man than do those of other experimental animals. Eighteen bonnet monkeys were exposed in chambers 7, 28, or 90 days, 8 hr per day, to 0.5 ppM or 0.8 ppM O_3 or filtered air. Three rhesus monkeys were exposed, on-line, to 0.1 ppM and another to 1.0 ppM O_3 for 3 hr. A significant exposure level effect with the long-term regimen for lung compliance was found suggesting increased levels of ozone exposure resulted in a loss of lung elasticity. Results suggest functional changes in small airways and alveoli which are consistent with respiratory bronchiolotis found to persist for 90 days of exposure in these monkeys. Initial injury may progress to a more severe and permanent injury such as chronic obstructive pulmonary disease.

MAN

REFER ALSO TO CITATION(S) 49471

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 49470

50633 (UR—3490-1556) **Microwaves affect thermoregulatory behavior in rats.** Stern, S.; Margolin, L.; Weiss, B.; Lu, S.T.; Michaelson, S.M. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 4p. (CONF-790627—1). P 02/MF A01.

From Bioelectromagnetics symposium; Seattle, WA, USA (18 Jun 1979).

Rats, with their fur clipped, pressed a lever to turn on an infrared lamp while in a cold chamber. When 2450 Megahertz continuous wave microwaves were presented for 15 minutes, the rate of turning on the infrared lamp decreased as a function of the microwave power density, which ranged between 5 MW/cm^2 and 20 MW/cm^2. This result indicates that behaviorally significant levels of heating occur at exposure durations and intensities that do not produce reliable changes in either colonic temperature or other behavioral measures. Further study of how microwaves affect thermoregulatory behavior may help us understand phenomena such as reported non-thermal behavioral effects of microwaves.

50634 (UR—3490-1557) **Behavioral procedure and 60 Hertz exposure system for determining field detection by rats.** Stern, S.; Laties, V.G.; Stancampiano, C.; Inglis, G.B.; Carstensen, E.; Michaelson, S.M.; Miller, M.W.; de Lorge, J.O. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics; Naval Aerospace Medical Research Lab., Pensacola, FL (USA)). 1979. Contract EY-76-C-02-3490. 4p. (CONF-790626—2). P 02/MF A01.

From 16. design automation conference; San Diego, CA, USA (25 Jun 1979).

A new system has been constructed to determine the threshold for detecting 60 Hertz electric fields by the rat. A variant of the Method of Constant Stimuli, which has been studied intensively by other investigators for determining the thresholds of animals to a variety of stimuli, will be used in the present study. The present report describes significant features of both the exposure system and behavioral paradigm designed to study the sensitivity of the rat to 60 Hertz electric fields.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 49568, 50637

50635 (RHO-LD—47) **Preliminary investigation into the theory and techniques of modeling the natural moisture movement in unsaturated sediments.** Finlayson, B.A.; Nelson, R.W.; Baca, R.G. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations; Washington Univ., Seattle (USA)). Feb 1978. Contract EY-77-C-06-1030. 148p. P 07/MF A01.

A study was performed on the problem of developing a general computer model of fluid flow processes in arid site soil systems. Major focus of the study was the investigation of traditional numerical techniques for solving the strongly nonlinear equations of unsaturated flow theory. A generalized mathematical model is formulated which considers the fluid flow processes of capillarity, gravity, thermally induced liquid and vapor transport, and heat conduction. The concepts advanced by Phillips and de Vries are used in describing the temperature effects of fluid transport. Three fluid phases are considered in the unsaturated flow model, namely: liquid, vapor, and air. The generalized model is expressed as five nonlinear partial differential equations. Numerical methods such as finite difference, collocation, and finite element techniques are reviewed and evaluated. Based on the numerical experiments of this study, a finite difference method with upstream weighing is found to be a recommended approach. This approach, however, possesses limitations related to the degree of nonlinearity. The degree of difficulty associated with solving the nonlinear partial differential equations is related to the properties of matrix stiffness. A preliminary computer model based on a simplified model formulation is applied using data for a field lysimeter. Comparisons between measured and computed moisture profiles are made for the lysimeter. Only qualitative agreement was obtained in these tests. In addition, the numerical solution technique was found to be stable for only certain cases. Further testing would be needed to fully check out this preliminary model.

50636 (USGS—474-306) **Bibliography of reports by US Geological Survey personnel on the Nevada Test Site and related subjects, July 1, 1977—December 31, 1978, with author and subject indexes.** Glanzman, V.M. (Geological Survey, Denver, CO (USA)). Jul 1979. Contract EY-76-A-08-0474; EW-78-A-08-1543;. 30p. P 03/MF A01.

This bibliography presents reports released to the public between July 1, 1977, and December 31, 1978, by personnel of the US Geological Survey. Reports include information on underground nuclear testing, waste management projects, the Nevada Test Site (NTS), and related subjects. Reports are listed by publication categories. Most reports are available to the public through the NTIS. Book publications of the US Geological Survey may be obtained from Branch of Distribution, US Geological Survey. 4 figures. (RWR)

GEOPHYSICS

SEISMOLOGY AND TECTONICS

50637 (NUREG/CR—0876) **Regional tectonics and seismicity of eastern Nebraska. Annual report, June 1977—May 1978.** Burchett, R.R.; Maroney, D.G. (Nebraska Univ., Lincoln (USA)). Jun 1979. 168p. C .

This report presents and interprets the information obtained by the Conservation and Survey Division (Nebraska Geological Survey) during the year June 1, 1977, to May 30, 1978. The information pertains to the geology, structure, tectonics, and seismicity of eastern Nebraska with emphasis on the vicinity of the Humboldt Fault Zone in western Richardson and eastern Pawnee counties. The scope of the studies is summarized as follows: rock outcrops in western Richardson and eastern Pawnee counties were reexamined and reevaluated, and 64 test holes were drilled to determine the altitude of the upper surface of the Tarkio Limestone of Pennsylvanian age; the possible relation of earthquakes in eastern Nebraska to Pleistocene glaciation was evaluated; three new seismograph installations were established in southeastern Nebraska; gravity surveys of western Richardson and eastern Pawnee counties were extended to the northern end of the Humboldt Fault Zone and were evaluated; ground magnetic surveys in western Richardson and eastern Pawnee counties were made and evaluated; gravity and

ground magnetic surveys of the Elk Creek Anomaly were made and evaluated. 30 figures, 1 table.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

50638 (SAND—77-1192) **Mechanical behavior of New Mexico rock salt in triaxial compression up to 200°C.** Wawersik, W.R.; Hannum, D.W. (Sandia Labs., Albuquerque, NM (USA)). Jul 1979. Contract EY-76-C-04-0789. 55p. P 04/MF A01.

Three groups of tests are discussed to identify the relative and site-specific importance of deviator stress, confining pressure (mean stress), temperature, time (loading rate), and stress path. The three groups of experiments consist of (1) hydrostatic loading, (2) conventional triaxial compression tests ($\sigma_1 > \sigma_2 = \sigma_3 = \text{const.}$), and (3) variable stress path tests including experiments at approximately constant σ_1 and at constant mean stress. All data were generated on 100 mm-diameter specimens. The rock salt exhibited nonlinear response under all loading conditions, practically zero initial elastic limit and an apparent inseparability of permanent deformations into time-independent and time-dependent components. Pressure and temperature did not alter the elastic constants but affected the principal strain ratio, the ratio of volumetric to shear strain, rock salt ductility, and the ultimate stress. In particular, low pressure and temperature permitted pronounced dilatancy and loss in load bearing ability. Under such conditions the volumetric strains reached sizable fractions of the shear strains. Pressure remained important even at high temperature because it influenced the rate of shearing. Load path and stress history may be significant under deviatoric loading conditions and for large variations in pressure. 17 figures.

50639 (UCRL—82133) **Computer modeling of inelastic wave propagation in porous rock.** Cheney, J.A. (Univ. of California, Davis); Schatz, J.F.; Snell, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Jan 1979. Contract W-7405-ENG-48. 11p. (CONF-7904100—1). P 02/MF A01.

From 3. international conference on numerical methods in geomechanics; Aachen, F.R. Germany (Apr 1979).

Computer modeling of wave propagation in porous rock has several important applications. Among them are prediction of fragmentation and permeability changes to be caused by chemical explosions used for in situ resource recovery, and the understanding of nuclear explosion effects such as seismic wave generation, containment, and site hardness. Of interest in all these applications are the distance from the source to which inelastic effects persist and the amount of porosity change within the inelastic region. In order to study phenomena related to these applications, the Cam Clay family of models developed at Cambridge University was used to develop a similar model that is applicable to wave propagation in porous rock. That model was incorporated into a finite-difference wave propagation computer code SOC. 10 figures, 1 table. (RWR)

50640 **Optical absorption and radiative heat transport in olivine at high temperature.** Shankland, T.J.; Nitsan, U.; Duba, A.G. (Geological Research Group, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **84**: No. B4, 1603-1610(10 Apr 1979).

The optical absorption spectra of natural single-crystal and polycrystalline olivine (mg/sub 1.84/Fe/sub 0.16/SiO_4) have been measured in the wavelength range 300—8000 nm at temperatures ranging from 300 to 1700 K and under oxygen fugacity well within the sample stability field. The absorption significantly increases with increasing temperature due to a regular broadening of both crystal field and multiphonon lattice vibrational absorption bands; these are the principal absorption bands in the spectral region involved in radiative heat transfer. In the 'window' region between these bands the absorption coefficient increases from near zero at 300 K to about 10—15 cm^{-1} at 1700 K. Under mantle conditions the radiative thermal conductivity (K/sub R/) calculated from the olivine single-crystal spectra increases from near zero at 300 K to about 5 x 10^{-3} cal/cm s K (2W/m K) at 1700 K and is only weakly dependent on temperature above 800 K. Our determination of K/sub R/ is 10—20% lower than previous estimates based on absorption measurements under different experimental conditions. In polycrystalline (dunite) samples the transmission decreased substantially with temperature cycling due to scattering at intergranular interfaces created by differential thermal expansion.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 49701, 49702, 49703

50641 **Model and observed circulation throughout the annual temperature cycle of Lake Michigan.** Allender, J.H.; Saylor, J.H. (Energy and Environmental Systems Division, Argonne National Laboratory, Argonne, IL 60439). *J. Phys. Oceanogr.;* **9**: No. 3, 573-575(May 1979).

Monthly average currents and temperatures predicted by a three-dimensional, numerical model of Lake Michigan are compared with observations made in that lake during June—October 1976. The observed data are from 17 urrent meters with integral temperature recorders that were concentrated on a transverse section of the southern basin of the lake. A brief interpretation of the overall aspects of these data is given and the evolution of a deep temperature anomaly in the west-central basin is discussed. Model results are evaluated in terms of their comparability with the dominant features of the observed data. Lakewide-average temperatures in the model are reasonable and the signs of the computed and observed currents show some agreement. However, the model exaggerates upwelling along the upwind (western) shore, leading to temperature predictions that worsen progressively throughout the stratified season. The present study and other recent work suggest the need for imporved mixed-layer physics in lake models.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

50642 (LBL—8920) **Measurement of the isotopic composition of galactic cosmic ray carbon, nitrogen and oxygen.** Wiedenbeck, M.E.; Greiner, D.E.; Bieser, F.S.; Crawford, H.J.; Heckman, H.H.; Lindstrom, P.J. (California Univ., Berkeley (USA). Space Sciences Lab.; California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 8p. (CONF-790836—3). P 02/MF A01.

From 16. international cosmic rays conference; Kyoto, Japan (6 Aug 1979).

The results of an investigation of the isotopic composition of galactic cosmic ray carbon, nitrogen and oxygen (E ~ 80 to 230 MeV/amu) made using the U.C. Berkeley HKH instrument aboard the ISEE-3 spacecraft are reported. The combination of high mass resolution and a large statistical sample makes possible a precise determination of the relative isotopic abundances for these elements. In local interplanetary space we find: $^{13}C/C = 0.067 +- 0.008$, $^{15}N/N = 0.54 +- 0.03$, $^{17}O/O < 0.027$, and $^{18}O/O = 0.019 +- 0.003$.

50643 (LBL—8921) **Isotopic composition of neon in the galactic cosmic rays: a high resolution measurement.** Greiner, D.E.; Wiedenbeck, M.E.; Bieser, F.S.; Crawford, H.J.; Heckman, H.H.; Lindstrom, P.J. (California Univ., Berkeley (USA). Space Sciences Lab.; California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 8p. (CONF-790836—4). P 02/MF A01.

From 16. international cosmic rays conference; Kyoto, Japan (6 Aug 1979).

A measurement of the isotopic composition of galactic cosmic ray neon in the energy range 70 to 260 MeV/amu has been made using the U.C. Berkeley HKH instrument aboard ISEE-3. A combination of high resolution and good statistical accuracy makes possible a precise determination of the local interplanetary neon composition. We find $^{22}Ne/^{20}Ne = 0.64 +- 0.07$ and $^{21}Ne/^{20}Ne < 0.30$ in local interplanetary space. These ratios, when interpreted in using standard galactic propagation and solar modulation models, yield cosmic ray source abundances which are inconsistent with a solar-like source composition.

50644 (LBL—9374) **Direct measurements of the spectrum of the near-millimeter cosmic background.** Richards, P.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 24p. (CONF-790697—1). P 02/MF A01.

From Universe at large redshifts conference; Copenhagen, Denmark (25 Jun 1979).

The spectrum of the cosmic background radiation peaks at 6 cm^{-1} and falls rapidly at higher frequencies. The experimental determination of this simple but important fact has had a long and troubled history. It remained in doubt long after the nature of the Rayleigh—Jeans region of the spectrum was firmly established. In this review, the experimental difficulties which have plagued cosmic background measurements at and beyond the peak in the spectrum are described. A critical evaluation of the present status of the field will then be given.

STARS

50645 **Transitory R-type ionization front in a Cepheid model.** Adams, T.F.; Castor, J.I. (University of California, Los Alamos Scientific Laboratory). *Astrophys. J.;* **230**: No. 3, 826-831(15 Jun 1979).

The hydrogen ionization front in a theoretical 9/sup d/x8 Cepheid model has been found to make a brief transition from D to R type when the amplitude of the pulsation is sufficiently large. This transition occurs at the phase of rapid expansion, when the front is racing inward. it is accompanied by the formation of a following shock on the neutral side of the front. The transition can be understood in terms of the theory of ionization fronts. When the pulsation amplitude is large, the density on the neutral side at this phase is too small for a steady-state D-type front to occur. The shock may be observable and may itself affect the limiting pulsation amplitude. The ability to study this phenomenon has been made possible by the use of a new pulsation code that has very fine non-Lagrangian zone, which follow the front as it moves in mass.

50646 Linear theory period ratios for surface helium enhanced double-mode Cepheids. Cox, A.N.; Hodson, S.W.; King, D.S. (Theoretical Division, Los Alamos Scientific Laboratory, University of California). *Astrophys. J., Lett.;* **230**: No. 2, L109-L112(1 Jun 1979).

Linear nonadiabatic theory period ratios for models of double-mode Cepheids with their two periods between 1 and 7 days have been computed, assuming differing amounts and depths of surface helium enhancement. Evolution theory masses and luminosities are found to be consistent with the observed periods. All models give $P_{1}/P_{0} \approx 0.70$ as observed for the 11 known variables, contrary to previous theoretical conclusions. The composition structure that best fits the period ratios has the helium mass fraction in the outer 10^{-3} of the stellar mass ($T <$ or $= 250{,}000$ K) as 0.65, similar to a previous model for the triple-mode pulsator AC And. This enrichment can be established by a Cepheid wind and downward inverted μ gradient instability mixing in the lifetime of these low-mass classical Cepheids.

50647 Instabilities of massive scalar perturbations of a rotating black hole. Zouros, T.J.M.; Eardley, D.M. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Ann. Phys. (N.Y.);* **118**: No. 1, 139-155(Mar 1979).

We study the stability of a massive scalar field in the exterior metric of a rotating Kerr black hole. An argument based on energy conversation shows, under some strong technical assumptions, that unstable normal modes exist. These unstable modes can be interpreted as wave packets in bound, superradiant orbits. A JWKB estimate of the fastest growth rate gives $10^{-7}M^{-1}\exp(-1.84M\mu)$ in the case $M\mu >> 1$, where M is the mass of the hole and psi is the mass of the field. The existence of unstable normal modes has significant implications for quantum particle creation by rotating black holes, which we attempt to assess.

SOLAR PHENOMENA

50648 Source of electrostatic fluctuations in the solar wind. Lemons, D.S.; Asbridge, J.R.; Bame, S.J.; Feldman, W.C.; Peter Gray, S.; Gosling, J.T. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **84**: No. A5, 2135-2138(1 May 1979).

Solar wind electron and ion distribution functions measured simultaneously with or close to times of intense electrostatic fluctuations are subjected to a linear Vlasov stability analysis. Although all distributions tested were found to be stable, the analysis suggests that the ion beam instability is the most likely source of the fluctuations.

50649 Long-distance neutrino detection , 1978. Saenz, A.W.; Uberall, H. (eds.). New York, NY; American Institute of Physics (1979). 158p. (CONF-780498—).

From American Institute of Physics Society-Division of Cosmic Physics; Washington, DC, USA (26 Apr 1978).

Individual papers were abstracted separately for the data base.

COSMOLOGY

50650 (BNL—26380) Broken symmetries and the problem of baryon excess of the universe. Mohapatra, R.N.; Senjanovic, G. (Brookhaven National Lab., Upton, NY (USA)). Jun 1979. Contract EY-76-C-02-0016. 24p. (CONF-790642—1). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics; Geneva, Switzerland (27 Jun 1979).

A class of gauge theories, where spontaneously broken symmetries, instead of being restored, persist as the temperature is increased is discussed. A renormalization group analysis of this phenomena suggests that there may be more than one phase transition in these models with at least one symmetric phase. Applying these ideas to the specific case of soft CP-violation in grand unified theories, a mechanism to generate the baryon to entropy ratio of the universe is discussed. 34 references.

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

50651 (LA—7926-MS) Effects of rocket exhaust products in the thermosphere and ionosphere. Zinn, J.; Sutherland, C.D.; Pongratz, M.B. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 23p. P 02/MF A01.

This report reviews the current state of understanding of the problem of ionospheric F-layer depletions produced by chemical effects of the exhaust gases from large rockets, with particular emphasis on the Heavy Lift Launch Vehicles (HLLV) proposed for use in the construction of solar power satellites. Also included, for verification of the computer model, is a computation of the effects of the Skylab I launch, for which experimental data exist. Launch plans for the HLLV call for orbital injection at 100- to 120-km altitude, and confinement of the main engine exhaust emissions to below 120 km. However, the exhaust products diffuse gradually upward to the ionospheric F-layer, where they react chemically with O^{+} ions, leading to the removal of ionization and causing a steady production of H atoms. The ion removal will lead to predictable consequences for HF communications systems and unpredictable effects on global weather. The number of H atoms produced per launch is about one-sixth of the normal total thermospheric H atom inventory. Detailed model computations of HLLV exhaust effects are described in this report.

EFFECTS OF NUCLEAR DETONATIONS

50652 (LA-UR—79-1992) Hugoniot measurements near 50 MBAR. Ragan, C.E. III. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 14p. (CONF-790709—5). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

A planar shock generated in the vicinity of an underground nuclear explosion was used to obtain Hugoniot data at 6.7 TPa for uranium relative to a molybdenum standard in an impedance matching experiment. Twenty-seven electrical contact pins were used to measure shock velocities of 27.0 and 22.8 km/s (+- 1%) in the molybdenum and uranium, respectively. The measurement differs from theory by more than 2.5 times the experimental uncertainty and represents the highest pressure at which Hugoniot data have been obtained.

MAGNETOSPHERIC PHENOMENA

50653 Entry of solar protons to the plasma sheet and lobe of the magnetotail AT r=18 R/sub E/ in the event of April 22, 1971. Palmer, I.D.; Jackson, J.C.; Hones, E.W. Jr. (Oral Roberts University, Tulsa, Oklahoma 74171). *J. Geophys. Res.;* **84**: No. A6, 2630-2640(1 Jun 1979).

Vela satellites of orbit r=18 R/sub E/ measured the intensity of $<$ or $\approx$ 1-MeV solar protons at two points in the plasma sheet and one in the north tail lobe during an 8-hour period on April 22, 1971. Intensities were isotropic, except when a sharp gradient was convected past a satellite. Several such gradients have been interpreted as the boundary between plasma sheet and north lobe. Movement of this plasma sheet surface has been observed in coincidence with substorm and geomagnetic storm activity. It is inferred that the region of open field lines at Vela orbit was very small in this event. A prolonged intensity difference by a factor of almost 2 existed across the surface between plasma sheet and lobe for $>$8 hours, implying very little cross-field transport of $<$ or $\approx$1-MeV protons. One gradient-induced anisotropy was anomalous in direction and has been explained by a tongue-shaped distortion in the surface separating plasma sheet and lobe. A second case of anomalous anisotropy from another event has been explained in a similar way. Intercomparison between Vela and Imp 6, the latter in interplanetary space, suggests the following. Access of $<$ or $\approx$1-MeV solar protons to the north tail lobe was delayed by 3-4 hours, giving an access point 602-872 R/sub E/ from earth. The intensity there was a little higher than the mean of the interplanetary distribution. The intensity in the dusk plasma sheet lay between the mean in interplanetary space and the integrated intensity of the backward moving interplanetary particles ($-1 < \mu < 0$). The intensity in the dawn plasma sheet was lower and tracked the integrated intensity of the backward moving particles in interplanetary space. This gradient across the plasma sheet at r=18 R/sub E/ implies that there was not a thorough mixing of $<$ or $\approx$1-MeV protons, at least on a time scale of hours.

50654 Magnetic fields in flowing magnetotail plasmas and their significance for magnetic reconnection. Caan, M.N.; Fairfield, D.H.; Hones, E.W. Jr. (Planetary Magnetospheres Branch, Laboratory for Extraterrestrial Physics NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771). *J. Geophys. Res.;* **84**: No. A5, 1971-1976(1 May 1979).

Results of a statistical analysis of 324 intervals of intense bulk plasma flows in the plasma sheet of the geomagnetic tail, measured by the Imp 6 spacecraft, are presented. Measurements of the magnetic field in the plasma sheet during these flows reveal pronounced dependences of the north-south magnetic field component B/sub z/ (GSM) and the earth-sun component B/sub x/(GSM) on the flow direction; no such dependence of the B/sub y/(GSM) component is discerned. Specifically, the fraction of field samples that are oriented southward is significantly greater during intervals of tailward flowing plasma than it is during intervals of earthward flowing plasma. Furthermore, this difference increases markedly as the absolute value of the angle of the magnetic field to the equatorial plane steepens. The total fraction of southward field, even during tailward flows, however, is about one third. As for the B/sub x/ component of the field, the distribution of samples in earthward flowing plasma is clearly peaked near zero, but the distribution in tailward flowing plasma is flatter and contains proportionately greater numbers of large positive and negative values of B/sub x/. A moderate increase in ground activity, as determined by the AE index, was observed to be associated with the intervals of plasma flows. These results are reviewed in the context of models of magnetic reconnection in the magnetotail and the geometry of the tail plasma sheet.

50655 Characteristics of the magnetospheric boundary layer and magnetopause layer as observed by Imp 6. Eastman, T.E.; Hones, E.W. Jr. (EGG. Inc., Los Alamos, New Mexico 87544). *J. Geophys. Res.;* **84**: No. A5, 2019-2028(1 May 1979).

Imp 6 observations of the low-latitude magnetospheric boundary layer indicate that the plasma within it is supplied primarily by direct entry of magnetosheath plasma across the magnetopause layer. We define the magnetopause layer as the current layer (separating the magnetosheath from the boundary layer) through which the magnetic field shifts in direction. High temporal resolution (3-s average) data reveal that in a majority of Imp 6 magnetopause crossing, no distinct changes in electron density or energry spectra are observed at the magne opause layer. In all Imp 6 crossings, some magnetosheathlike plasma is observed earthward of the magnetopause layer, implying the existence of a boundary layer. Boundary layer electron energy spectra are often virtually indistinguishable from the adjacent magnetosheath spectra. Low-latitude boundary layer bulk plasma flow as observed by Imp 6 almost always has an antisunward component and often has a significant cross-field component. The boundary layer thickness is highly variable and is generally much larger than the magnetopause layer thickness. Energetic electron pitch angle distributions indicate that the low-latitude boundary layers is normally on closed field lines. We conclude that diffusive as well as nondiffusive processes probably contribute to the entry of magnetosheath plasma into the boundary layer.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

50656 (UCRL—82270) **Effects of cellular structure on the behavior of gaseous detonation waves under transient conditions.** Urtiew, P.A.; Tarver, C.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Jul 1979. Contract W-7405-ENG-48. 39p. (CONF-790828—2). P 03/MF A01.

From 7. international colloquium on gas-dynamics of explosions and reactive systems; Gottingen, F.R. Germany (20 Aug 1979).

Increased concern about the detonability of gaseous mixtures in unconfined clouds renewed our interest in the behavior of the detonation process under various transient conditions, such as a nonuniform distribution of pressure, temperature, or composition. In readjusting itself during such a transient state, the process may either survive and continue as a detonation wave or may weaken so fast that it transforms into a simple deflagration wave. A similar transient condition may be imposed on the wave by letting it pass through an area change. Here again, the wave may either survive or weaken to a point of its extinction. Assuming that the cellular structure of the detonation wave is responsible for its existence and its uniqueness, the effect of variation in the cross-sectional area of the tubes on the cell size and on the survival of the detonative process during the transition were investigated. Comparison was made with the results of other investigators who performed similar experiments for different reasons. the results show that it is not the tube diameter nor the initial pressure of the medium that controls the survival of the wave but that it is (1) the number of cells available to endure losses from flow effects generated by the transient conditions and (2) the number of cells remaining to regenerate new cells to revive the detonation process.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 50331

ATOMIC AND MOLECULAR PROPERTIES

50657 (LBL—7701) **Symposium commemorating the 25th anniversary of elements 99 and 100.** Seaborg, G.T.; Webb, C. (eds.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 89p. (CONF-780134—). P 05/MF A01.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

Separate abstracts were prepared for five of the contributions to this symposium. The four remaining ones have already been cited in ERA and may be located by reference as the entry CONF-780134— in the Report Number Index. (RWR)

50658 (LBL—7701, pp 69-72) **Free ion spectroscopy of einsteinium and comments on fermium.** Conway, J.G. (Lawrence Berkeley Lab., CA). Apr 1979.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

The spectroscopy of einsteinium is presented and other relevant atomic data are cited to give an understanding of the status of that element. Information on the continuing work on einsteinium is given. A few comments on fermium are made. 6 figures, 1 table. (RWR)

50659 (UCRL—82596) **Determination of absolute quantum efficiencies by photoacoustic spectroscopy.** Rosencwaig, A.; Weber, M.J.; Saroyan, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Apr 1979. Contract W-7405-ENG-48. 8p. (CONF-790819—5). P 02/MF A01.

From Topical meeting on photoacoustic spectroscopy; Ames, IA, USA (1 Aug 1979).

A method is described whereby the absolute radiative quantum efficiency of paramagnetic ions in liquids or solids can be determined from photoacoustic measurements. 1 figure.

50660 k ordering of atomic energy levels and its relation to the spectroscopic quantum defects. Sternheimer, R.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., A;* **20**: No. 1, 18-26(Jul 1979).

The k-ordering properties of the spectra of atoms and ions consisting of a single valence electron outside a core of closed shells (k=n+l) have been introduced and discussed extensively in four previous papers, together with the constant l sequences within each group of levels having the same value of k (k bands). In the present paper, it is demonstrated that the spectroscopic quantum defects δ/sub n/l play the role of the "order parameter" for the k-ordering phase of the excited-state spectra. Thus only penetrating orbitals, i.e., those having a large δ/sub n/l (δ/sub n/l> or ≃0.2), exhibit the phenomenon of k ordering, and in particular, the curves of δ/sub n/l vs l (for fixed k) are generally curved downwards, with an abrupt decrease to values of δ/sub n/l close to zero at the limiting angular momentum l_1, which has been previously introduced. The curves of δ/sub n/l vs l are basically similar to the curves of magnetic field H as a function of temperature T in a ferromagnet, with an abrupt decrease to δ/sub n/l∼0 at l_1, which can therefore be regarded as the analog of the Curie temperature T/sub C/. The "reduced quantum defects" eta/sub n/lequivalentδ/sub n/l+ l-l_1 (for l< or =l_1) have also been introduced. It is shown that the ordering of the eta/sub n/l values for l< or =l_1 determines the nature of the l patterns of the spectrum, e.g., dpsf, dpfs, or pdsf.

50661 3^2S/sub 1/2/-3^2D/sub 5/2/ interval in atomic hydrogen. II. Experimental and results. Clark, B.O.; Van Baak, D.A.; Lundeen, S.R.; Pipkin, F.M. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., A;* **20**: No. 1, 239-253(Jul 1979).

This paper reports a double-quantum radiofrequency measurement of the 3^2S/sub 1/2/-3^2D/sub 5/2/ fine-structure interval in hydrogen. The measurement was carried out in zero magnetic field with a fast hydrogen beam. The measured value for the 3 ^{2}S/sub 1/2/-3 ^{2}D/sub 5/2/ interval is 4013.204(78) MHz. This is in good agreement with the theoretical value.

50662 Radiation-catalyzed ortho-to-para transition in solid tritium. Gaines, J.R.; Tsugawa, R.T.; Souers, P.C. (Department of Physics, Ohio State University, Columbus, Ohio 43210). *Phys. Rev. Lett.;* **42**: No. 25, 1717-1719(18 Jun 1979).

The ortho-to-para conversion time in solid tritium has been measured by NMR techniques. The observed rate is at least ten times faster than the temperature-independent self-conversion in solid H_2 and increases exponentially as the temperature decreases, e.g. the 1/e times are 490 min at 22.5 K and 64 min at 9.1 K. Because of the analogous situation in solid H_2, where atomic H is created when the solid is irradiated, it appears that in T_2, the T atoms are the most likely catalysts for the ortho-para conversion.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

50663 (JINR-D—1,2,14-10908, pp 29-39) **Fuzzy Fermi-Teller model of negative meson capture by atoms.** Leon, M. (Los Alamos Scientific Lab., NM (USA)). 1977.

From International symposium on meson chemistry and mesomolecular processes in matter; Dubna, USSR (7 Jun 1977).

In the framework of the modified fuzzy Fermi-Teller model, electron-meson scattering is considered. Probability distributions for different kinds of collisions are calculated for a variety of nonperturbed meson orbits. To model the slowing-down, initial capture and subsequent deexcitation of mesons the Monte-Carlo simulation is used. The basic steps in the Monte-Carlo calculations are outlined. The procedure makes it possible to get the distributions in angular momentum of captured mesons at various stages of the cascade, the meson distribution in energies from which capture takes place, and other values. The model yields the distribution in n and l quantum numbers which is used to start a quantum-mechanical cascade and hence to predict X-ray intensities. The directions in improving the model are outlined.

50664 (JINR-D—1,2,14-10908, pp 110-117) **Muon capture in metallic, chemical and solution systems - recent results and future plans at Los Alamos.** Naumann, R.A.; Schmidt, G. (Los Alamos Scientific Lab., NM (USA)); Knight, J.D.; Mausner, L.F.; Orth, C.J.; Schillaci, M.E. (Princeton Univ., NJ (USA)). 1977.

From International symposium on meson chemistry and mesomolecular processes in matter; Dubna, USSR (7 Jun 1977).

The recent results on capture ratios and the KX-ray intensity patterns in negative muon capture experiments carried out at Los Alamos are outlined. A set of experiments was devoted to capture process in alkali halide compounds. The capture ratio for alkali chlorides and for potassium halides was found to reveal the fall-out with increasing atomic number. The measurements carried out on aqueous ions of NaCl verifies the indication that the muonic KX-ray intensity patterns show enhanced intensity of the higher K numbers in comparison to that in crystalline NaCl. The systematic investigations of the variations of the K mesic X-ray intensity pattern was carried out for pure elements with atomic number ranging from 6 to 34. The dependence of the X-ray intensity pattern on atomic number exhibits a maximum in the vicinity of Z=25 (manganese). Another research program is concerned with quantitative tests of the dependence of the muon capture on composition for solid solutions. Measurements are underway using two binary metallic alloy systems of aluminium-copper, silver-zinc and three continuous solid solutions formed by sodium chloride-sodium bromide, potassium chloride-potassium bromide and potassium bromide-potassium iodide.

50665 **O ($\alpha^2 \ln(\alpha^{-1})$) corrections in positronium: Hyperfine splitting and decay rate.** Caswell, W.E.; Lepage, G.P. (Department of Physics, Brown University, Providence, Rhode Island 02912). *Phys. Rev., A;* **20**: No. 1, 36-43(Jul 1979).

The authors have analyzed the terms of relative order $\alpha^2 \ln(\alpha^{-1})$ that come from annihilation kernels in positronium, and have found a contribution of $\alpha^6 \ln(\alpha^{-1})$ m/sub e//24 to positronium hyperfine splitting from annihilation kernels, including several new contributions. The resulting hyperfine splitting is 203.4003 GHz, with terms of order α^6m/sub e//2$\sim$0.01 GHz uncomputed. The contributions to the decay rates of ortho- and parapositronium have also been calculated. For orthopositronium the result is $-\alpha^2 \ln(\alpha^{-1})\ \Gamma_0/3$. The authors present in more detail the theoretical analysis leading to their previous $\alpha\Gamma_0$ calculation and improve on the numerical results. The resulting theoretical orthopositronium decay rate is 7.0386 +- 0.0002 μsec^{-1}, with terms of order $\alpha^2\Gamma_0$=0.0004 μsec^{-1} uncalculated.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 50377, 50663, 50840

50666 (LA-UR—79-1524) **Multiple-photon excitation of polyatomic molecules in a strong optical field: a universal normalization.** Robinson, C.P.; Judd, O.P. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 93p. (CONF-790690—1). P 05/MF A01.

From 4. international conference on laser spectroscopy; Rottach-Egern, Tegernsee, F.R. Germany (11 Jun 1979).

The phenomenon of Multiple Photon Excitation (MPE) of polyatomic molecules by a (laser) optical field has proved to be quite general. We have been attempting for some time to relate the absorption response of a molecule to the optical driving force in terms of a general model which would take into account the important molecular parameters. A picture of the interaction has emerged which emphasizes the dynamics of absorption within a single vibrational manifold with rapid intramodal coupling to other vibrational modes. The similarity between this picture of the excitation process by an optical field and the de-excitation process for vibrational relaxation of polyatomics provided strong motivation to seek a universal curve for the MPE process by analogy to the Lambert—Salter correlation for relaxation processes.

50667 (LA-UR—79-2040) **Photonic compression.** Shaner, J.W. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 8p. (CONF-790709—9). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

Lasers developed for fusion applications now have the capability of creating pressures in excess of 100 Mbar in the laboratory. The capability of these lasers for making high pressure equation of state measurements, progress toward that goal, and the problems which stand in the way are reviewed.

50668 (UCRL—15100) **Compton scattering.** Botto, D.J.; Pratt, R.H. (Pittsburgh Univ., PA (USA). Dept. of Physics and Astronomy). May 1979. Contract W-7405-ENG-48. 54p. P 04/MF A01.

The current status of Compton scattering, both experimental observations and the theoretical predictions, is examined. Classes of experiments are distinguished and the results obtained are summarized. The validity of the incoherent scattering function approximation and the impulse approximation is discussed. These simple theoretical approaches are compared with predictions of the nonrelativistic dipole formula of Gavrila and with the relativistic results of Whittingham. It is noted that the A^{-2} based approximations fail to predict resonances and an infrared divergence, both of which have been observed. It appears that at present the various available theoretical approaches differ significantly in their predictions and that further and more systematic work is required.

50669 (UCRL—82127) **Shock compression of liquid methane and the principle of corresponding states.** Nellis, W.J.; Mitchell, A.C.; Ross, M.; van Thiel, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Jul 1979. Contract W-7405-ENG-48. 7p. (CONF-790709—8). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

The principal Hugoniot of liquid methane has been measured between 5 to 43 GPa and a doubly-shocked state has been measured at 91 GPa. The repulsive pair potential for methane and argon are demonstrated to obey the principle of corresponding states.

50670 (UCRL—82129) **High-pressure and high-temperature behavior of simple and complex molecular liquids.** Ree, F.H.; Ross, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Jul 1979. Contract W-7405-ENG-48. 8p. (CONF-790709—11). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

Recent theories in statistical mechanics and intermolecular forces are used to explain the shock-wave data of inert gases, diatomic molecules, and hydrocarbons.

50671 **Absolute cross sections for 2s-2p excitation of N^{4+} by electron impact.** Gregory, D.; Dunn, G.H.; Phaneuf, R.A.; Crandall, D.H. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80309). *Phys. Rev., A;* **20**: No. 2, 410-420(Aug 1979).

Absolute cross sections have been measured for $1s^22s\ ^2S$/sub 1/2/-$1s^22p\ ^2P$/sub 1/2,3/2/ excitation of lithiumlike N^{4+} by electron impact. For this process, which has a threshold at 10 eV, relative cross sections measured at several energies between 4 and 52 eV were normalized to a single absolute measurement taken at 15.5 eV. Similar data for Li-like C^{3+} have been previously reported and are presented for comparison. In both cases, allowing for the experimental electron energy spread, the measurements agree within experimental uncertainties with published Coulomb-Born and close-coupling calculations over the entire experimental energy range. Rate coefficients as a function of electron temperature are also presented for the N^{4+} transition.

50672 **Scaled electron ionization cross sections in the Born approximation for atoms with 55< or =Z< or =102.** McGuire, E.J. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., A;* **20**: No. 2, 445-456(Aug 1979).

Using the generalized oscillator-strength formulation of the Born approximation, the author calculated electron ionization cross sections for all significant subshells of every fourth atom with 58< or =Z< or =102, and for Hg. The calculations used approximate Herman-Skillman wave functions and eigenvalues. The cross sections were put in scaled form, depending essentially on ionization energy only. The scaled cross sections were used with experimental energies to calculate the cross sections for Cs, Cs^+, Ba, Ba^+, Au, Hg, Tl, Tl^+, and Pb. The cross sections so calculated were in good agreement with the measurements. Both inner-shell ionization and excitation followed by autoionization were prominent contributors

to the cross section. The scaling procedure was used to calculate the electron ionization cross section of the noble-gas metastable levels, and there is excellent agreement with measured values for Ne and A. The scaling procedure was used to calculate cross sections for the sequential ionization Ni^{+1}—Ni^{+14} and Au^{+3}—Au^{+14}, which were compared with cross sections obtained from the semiempirical expression of Lotz. Good agreement was found for the Ni ions, but there was poor agreement for the Au ions. Lotz's expression is a factor of 3 smaller than our scaled cross section for the 4d, 4f, and 5d subshells. It is suggested that the absence of measurements on these subshells precluded correct parametrization in the semiempirical expression of Lotz.

50673 Electrons in superheavy quasimolecules. Soff, G.; Greiner, W.; Betz, W.; Mueller, B. (Department of Physics and Astronomy, Nuclear Physics Division, Vanderbilt University, Nashville, Tennessee 37203). *Phys. Rev., A;* **20**: No. 1, 169-193(Jul 1979).

Binding energies and wave functions of inner-shell electronic states in superheavy quasimolecules with (Z/sub p/ + Z/sub t/) α > 1 are calculated. Ionization during a collision of very heavy ions is investigated within a molecular basis generated by the solutions of the two-center Dirac equation. Transitions to vacant bound states as well as direct excitation to the continuum are taken into account. We present theoretical values for the ionization probability as a function of impact parameter, bombarding energy, and combined nuclear charge. Our computed results are compared with recent experimental data. It is suggested that relativistic binding energies of electrons in superheavy quasimolecules can be determined experimentally via the impact-parameter dependence of ionization and the anisotropy of quasimolecular radiation.

50674 Atomic motion in resonant radiation: An application of Ehrenfest's theorem. Cook, R.J. (University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Phys. Rev., A;* **20**: No. 1, 224-228(Jul 1979).

A new theory of atomic motion in a resonant or near-resonant electromagnetic wave, based on Ehrenfest's theorem and the optical Bloch equations, is presented. The theory provides a simple unified treatment of the radiation force, including effects of spontaneous emission and induced-dipole interactions. Analytical results are presented for a plane running wave, a general standing wave, a collimated Gaussian beam, and a combination of standing and running waves.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 50673

50675 (UCRL—52815) **Studies in molecular dynamics of the friction coefficient and the Lorentz gas.** Alley, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1979. Contract W-7405-ENG-48. 185p. P 09/MF A01.

Thesis.

The thesis consists of three hard-sphere molecular dynamics studies. The first describes a modification of Fick's diffusion law, required whenever long-time correlations are present. The second study concerns the mass and size dependence of the friction coefficient as well as its dependence on boundary conditions. The study presents a molecular dynamics method which calculates the infinite-mass friction coefficient of finite size hard-sphere particles. The third study presents the applicability of hydrodynamics to describe fluctuations in fluids on the molecular level. This study shows that the fluctuations present in a system of hard spheres when placed between closely spaced parallel hard walls lead to an acoustical resonance for those wavelengths which correspond to the spacing, or integer fractions thereof.

50676 Coherent dynamics of N-level atoms and molecules. III. An analytically soluble periodic case. Cook, R.J.; Shore, B.W. (University of California, Lawrence Livermore Laboratory, P. O. Box 808, Livermore, California 94550). *Phys. Rev., A;* **20**: No. 2, 539-544(Aug 1979).

By employing an analogy with a spin-J system in a constant magnetic field the authors obtain a simple soluble model for stepwise laser excitation of an N-level system (N=2J+1), including analytic treatment of Doppler detuning and of ionization loss. The solutions are periodic and hence permit complete population inversion. A simple graphical realization of the population dynamics, a generalization of the Feynman, Vernon, and Hellwarth vector model of the two-level Bloch equation, is then described.

50677 Electromagnetic potential in Thomas-Fermi-Dirac atoms. Gross, E.K.U.; Rafelski, J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **20**: No. 1, 44-47(Jul 1979).

The authors discuss the relativistic Thomas-Fermi model for atoms and derive a relativistic extension of the Dirac exchange term. As a result of this model the mutual cancellation of the exchange and relativistic corrections to the energies of inner-shell electrons in heavy atoms (Z > 50) is demonstrated.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 50670, 50675

50678 (UCRL—52792) **VISAR analysis at the Lawrence Livermore Laboratory with the four-detector system.** Goosman, D.R.; Parker, N.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jun 1979. Contract W-7405-ENG-48. 21p. P 02/MF A01.

A detailed description is presented of the analysis of velocity-vs-time data taken with LLL's four-phototube VISAR system. Separate sections deal with a general analysis of on-axis rays when only one frequency of reflected laser light is present, a simplified analysis where two distinct frequencies are present and the rays are still on axis, and a discussion of the effects of off-axis rays. The description is given in such a manner that a VISAR user could employ the formulae in this report to directly analyze data. Unlike previous literature on the VISAR, this analysis does not assume that the mirrors are set at the best fringe contrast position.

50679 Hybrid vortex-ADI solution for flows of low viscosity. Shestakov, A.I. (Lawrence Livermore Laboratory, Livermore, California 94550). *J. Comput. Phys.;* **31**: No. 3, 313-334(Jun 1979).

A hybrid numerical scheme is presented for use on two-dimensional, incompressible flows of low viscosity. The scheme divides the domain D into two regions, D_1, and D_2, and the Navier-Stokes equations are solved by different methods in each. in the region D_1, which is composed of a narrow strip adjoining the boundary, the grid-free vortex method is used. An alternating direction implicit (ADI) method is used in the interior domain D_2 which contains that part of D that lies a short distance away from the boundary. The hybrid method allows vorticity exchange between the two regions by partially merging and realigning them. Boundary conditions for the vorticity are automatically treated by the vortex method. Favorable numerical results have been obtained for the problem of recirculating flow in a square cavity for Reynolds number of 400 and 1000.

PROPERTIES AND STRUCTURE OF FLUIDS

50680 Surface-wave propagation on isotropic liquids: A study of two-mode structure. Sohl, C.H.; Miyano, K. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., A;* **20**: No. 2, 616-620(Aug 1979).

The dispersion relation for capiliary waves on isotropic fluids is written in a dimensionless form appropriate for propagation experiments and solved numerically. Using a recently developed technique to generate and detect capillary waves, the authors have observed a second mode on a highly viscous fluid whose characteristics are in good agreement with theory.

MAGNETOHYDRODYNAMICS

50681 Magnetohydrodynamic particle code for fluid simulation of plasmas. Leboeuf, J.N.; Tajima, T.; Dawson, J.M. (Department of Physics, University of California, Los Angeles, California 90024). *J. Comput. Phys.;* **31**: No. 3, 379-408(Jun 1979).

A novel Lagrangian type of MHD code has been developed by treating elements of the fluid as finite-sized particles. The particle quantities i.e., position, mass, momentum and temperature, are pushed in a Langrangian way, while the magnetic fields are advanced in an Eulerian manner. The fully Lagrangian fluid is represented by a distribution of Gaussian-shaped particles. Drag forces between particles with different velocities in the same cel prevent extensive multi-streaming from developing. A combination of finite differences, to calculate the magnetic field, and fast Fourier transforms, to evaluate the pressure gradient term, guarantees momentum and magnetic flux conservation. The use of particles eliminates many difficulties often associated with Eulerian codes such as, for example negative densities. The method also means that any particle code o which there are many can be converted to a fluid code. The code have been extensively tested with the propagation of sound waves Alfven and magnetosonic wave among others. Applications of th codes to hydrodynamics and magnetohydrodynamics in one, tw and three dimensions, in cartesian as well as in toroidal geometry are further discussed.

SUPERFLUIDITY

50682 Anisotropy and flow in ^{3}He-A. Kleinberg, R.L. (Department of Physics, University of California: San Diego, La Jolla, California). *J. Low Temp. Phys.;* **35**: No. 5, 489-533(1 Jun 1979).

Thermally driven counterflow in ^{3}He-A is investigated, using techniques that exploit the anisotropy of the fluid. The results are discussed in terms of both uniform-texture and helical-texture hypotheses. Anisotropy of heat flow is observed for the first time and a limitation of the superfluid velocity is strongly suggested.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

50683 High energy physics with polarized beams and polarized targets (Argonne, 1978). Thomas, G.H. (ed.). New York, NY; American Institute of Physics (1979). 509p. (CONF-781095—).

From Symposium on high energy physics; Argonne, IL, USA (26 Oct 1978).

Individual papers were abstracted separately for the data base.

ELECTROMAGNETIC INTERACTIONS

50684 (LBL—9234) **First results from the Berkeley—Fermilab—Princeton multimuon spectrometer.** Strovink, M. (California Univ., Berkeley (USA)). May 1979. Contract W-7405-ENG-48. 23p. P 02/MF A01.

Muon interactions in a magnetized-steel calorimeter have produced 1000 +- 80 muons from J/psi(3100) decay, and 3 final states containing > 3 energetic muons. Use of proportional and drift chambers fully sensitive in the forward direction has resulted in uniform high acceptance for these processes, with 9% mass resolution. The psi photoproduction cross section continues to rise above 30 GeV, at a rate smaller than that predicted by a QCD calculation. Its Q^2-dependence fits $(1 + Q^2/M^2)^{-2}$ with M = 2.7 +- 0.5 GeV.

50685 (ORO—2504-292) **Search for axion production in low energy electron bremsstrahlung.** Bechis, D.J.; Dombeck, T.W.; Ellsworth, R.W.; Sager, E.V.; Steinberg, P.H.; Teig, L.J.; Yoh, J.K.; Weitz, R.L. (Maryland Univ., College Park (USA). Dept. of Physics; Columbia Univ., New York (USA). Dept. of Physics; Armed Forces Radiobiology Research Inst., Bethesda, MD (USA)). Mar 1979. Contract EY-76-C-05-2504. 13p. P 02/MF A01.

Results of an experiment to detect axions produced by bremsstrahlung of 45 MeV electrons are presented. No signal is found. The upper limits are interpreted in terms of two models. 22 references.

50686 Observation of J/psi (3100) production by 209-GeV muons. Clark, A.R.; Johnson, K.J.; Kerth, L.T.; Loken, S.C.; Markiewicz, T.W.; Meyers, P.D.; Smith, W.H.; Strovink, M.; Wenzel, W.A.; Johnson, R.P.; Moore, C.; Mugge, M.; Shafer, R.E.; Gollin, G.D.; Shoemaker, F.C.; Surko, P. (Physics Department and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 3, 187-190(16 Jul 1979).

Interactions of 209-GeV muons within a magnetized-steel calorimeter have produced 1000 +- 80 $\mu^+\mu^-$ pairs from J/psi (3100) decay. Redundant systems of proportional and drift chambers maintained uniform acceptance and 9% mass resolution. Above 30 GeV, the cross section for psi production by virtual photons is found to rise less steeply with energy than predicted by a quantum chromodynamics calculation. Its dependence on Q^2 fits the vector-dominance form $(1 + Q^2/M^2)^{-2}$ with M = 2.7 +- 0.5 GeV.

50687 Production of anti Σ^{+-}'s in e^+e^- annihilations. Ferguson, T.; Buchanan, C.; Nodulman, L.; Poster, R. (California Univ., Los Angeles (USA)); Breidenbach, M.; Morehouse, C.C.; Vannucci, F. (Stanford Linear Accelerator Center, CA (USA)). *Phys. Lett., B;* **79**: No. 1, 161-164(6 Nov 1978).

An increase in anti Σ^{+-} production between Esub(cm) = 4 and 7 GeV is found which is consistent with charmed baryon production models. A search for the decay anti Λ^-sub(c)→anti $\Sigma^{+-}\pi^{-+}\pi^-$ yields no significant peaks.

50688 Limits on the production of large transverse momentum direct photons deduced from the measurement of low-mass electron pairs. Cobb, J.H.; Iwata, S.; Palmer, R.B.; Rahm, D.C.; Rehak, P.; Stumer, I. (Brookhaven National Lab., Upton, NY (USA)); Fabjan, C.W.; Fowler, E.; Mannelli, I.; Mouzourakis, P. *Phys. Lett., B;* **78**: No. 4, 519-522(9 Oct 1978).

The hadronic production of electron pairs with masses between 200 and 500 MeV and large transverse momentum has been measured at the CERN Intersecting Storage Rings (ISR). The expected relation between low-mass electron pairs and real photons is used to determine the direct hadronic production of photons. Contrary to indications from some previous experiments, the observed spectrum is consistent with expectations from the decay of known mesons, and leads to a value for the ratio of direct photons to π^0 of $\gamma/\pi^0 = (0.55 + -0.92)\%$ for 2<psub(T)<3 GeV and <$\sqrt{s}$> = 55 GeV.

50689 Neutron electric dipole moment. Dress, W.B.; Miller, P.D. (Oak Ridge National Lab., TN (USA)). pp 11-14 of Fundamental physics with reactor neutrons and neutrinos. von Egidy, T. (ed.). Bristol; Institute of Physics (1978).

From Workshop on fundamental physics experiments with reactor neutrons and neutrinos; Grenoble, France (10 Oct 1977).

A summary of the theoretical and experimental work carried out since 1951 on the search for the neutron electric dipole moment (EDM) is given. The present data can be said to rule out only the electromagnetic (to at least third order) and the unadorned weak interaction. The bulk of the milli-weak theories lie just above the present limit of 3 x 10^{-24} cm for the neutron's EDM length, whereas the higher-order milli-weak, milli-strong and super-weak theories are yet to be tested. To extend the limit below 10^{-25} cm it will become exceedingly difficult to use the conventional neutron-beam magnetic resonance method and the use of ultra-cold neutrons (UCN) is considered. A projected experiment using UCN storage techniques to search for the EDM of the neutron is discussed.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 50684, 50703

50690 (RL—78-081, pp 62-67) **Neutrino-deuterium reactions in the 7-foot bubble chamber.** Kahn, S.A.; Chops, A.M.; Connolly, P.L.; Kirk, H.G.; Murtagh, M.J.; Palmer, R.B.; Samios, N.P.; Tanaka, M. (Brookhaven National Lab., Upton, NY (USA)). 1978.

From Conference on neutrino physics at accelerators; Oxford, UK (3 Jul 1978).

Recent results from the analysis of 569,000 ν pictures taken in the BNL 7-ft bubble chamber filled with D_2 (and an additional 204,000 pictures in H_2) are reported. The statistics of the current analysis include 648 quasi-elastic νsub(μ)d → μ^-ppsub(s) events and 25 events with visible strangeness present. Using the quasielastic events in the framework of the conventional V-A theory, it is found that Msub(V) = 0.87 +- 0.09 GeV and Msub(A) = 1.03 +- 0.19 GeV. The present value is in good agreement with the CVC prediction of Msub(V) = 0.84 GeV. With the fixed value of Msub(V) = 0.84 GeV, a one parameter fit yields Msub(A) 1.08 +- 0.08 GeV. Eight events were also found in the exclusive channel $\nu n \rightarrow \mu^- K^+ \Lambda$ in agreement with a theoretical calculation using the generalised Born approximation.

50691 (RL—78-081, pp 58-61) **Simple charged-current channels in ν-D_2 interactions.** Levman, G.; Derrick, M.; Hyman, L. (Argonne National Lab., IL (USA)). 1978.

From Conference on neutrino physics at accelerators; Oxford, UK (3 Jul 1978).

Updated results from a study of low energy ν-D_2 interactions using the ANL 12-Foot Bubble chamber are presented. These results for the quasi-elastic reaction $\nu n \rightarrow \mu^- p$ and single pion production final states $\mu^-\pi^+ p$, $\mu^-\pi^0 p$ and $\mu^-\pi^+ n$ are from a total exposure of 2.3 x 10^{19} protons on target. The axial-vector form factor mass in quasi-elastic scattering, assuming a dipole form, is determined to be Msub(A) = 0.98 +- 0.08 GeV. The single pion production channels are in good agreement with the predictions of the Adler (Ann. Phys. N.Y.; 50:189 (1968)) model of weak pion production. In particular, the I = 1/2 pion-nucleon amplitude is substantial and relative to the I = 3/2, is determined to be αAsub(1/2)α/αAsub(3/2)α 0.57 +- 0.06.

50692 Detection of weak neutral current using fission nu-bar/sub e/ on deuterons. Pasierb, E.; Gurr, H.S.; Lathrop, J.; Reines, F.; Sobel, H.W. (Department of Physics, University of California at Irvine, Irvine, California 92717). *Phys. Rev. Lett.;* **43**: No. 2, 96-99(9 Jul 1979).

The weak-neutral-current reaction ν-bar/sub e/ + d → n + p + ν-bar/sub e/ has been observed concurrently with the charged-current process ν-bar/sub e/ + d → n + n + e^+ using an instrumented D_2O target exposed to an ν-bar/sub e/ flux of 2.5 x 10^{13} $cm^{-2}sec^{-1}$. The measured neutral-current cross section, (3.8 +- 0.9) x 10^{-45} cm^2/ν-bar/sub e/, is consistent with the Weinberg-Salam model, dependent in this case only on the axial-vector contribution. The charged-current reaction cross section is (1.5 +- 0.4) x 10^{-45} cm^2/ν-bar/sub e/, in fair agreement with expectation.

50693 Inclusive electroproduction from protons and deuterons. Martin, J.F.; Feldman, G.J.; Hanson, G.; Lyon, D.E.; Perl, M.L.; Pun, T.P.; Bolon, C.; Lanza, R.C.; Luckey, D.; Osborne, L.S.; Roth, D.G.; Dakin, J.T. (Stanford Linear Accelerator Center, Stanford

University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 1, 5-20(1 Jul 1979).

We present results on the inclusive distributions of final-state hadrons created in deep-inelastic electron scattering from protons and deuterons. Data were taken from all portions of the kinematic range simultaneously in an apparatus which had equal detection efficiency for both charge signs. A subset of the produced hadrons were identified with a threshold-type Cerenkov counter. We find that the charge ratio h^+/h^- is a strong function of Q^2, x/sub F/, and p/sub T//sup ts2/, with little dependence on s. The ratio of production of h^- from deuterium to that from hydrogen as a function of phi is flat. The invariant cross section for each charge sign and each target exhibits the seagull effect (a correlation in <p/sub T/> and <x/sub F/>). The value of <p/sub T/> for data in the range 0.4 < x/sub F/ < 0.85 increases slightly as Q^2 increases. The exponential dropoff in p/sub T/ for production of protons and kaons is similar to that for pions. The dropoff in x/sub F/ for production of pions shows a definite dependence on Q^2, but this effect is largely caused by the decay products of the exclusive rho^0 final state. Finally, f (x/sub F/) for π^+, π^-, K^+, K^-, p, and p-bar is presented for each target type.

50694 Search for massive, long-lived, fractionally charged particles produced by 300-GeV protons. Stevenson, M.L. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **20**: No. 1, 82-86(1 Jul 1979).

A search has been made for massive, long-lived, weakly interacting particles of fractional charge that could be produced by 300-GeV protons striking an aluminum target. The search was most sensitive to particles with a lifetime of about 100 μsec. These particles would have come to rest in the Caltech neutrino detector that was located halfway down the muon shield, and if they were massive enough and decayed into at least 5 GeV of visible energy in the calorimeter, they could have been detected. None were found. The 90%-confidence-level upper limit to the invariant cross section (times branching ratio R), $REd^3\sigma/dp^3$ [$cm^2/(GeV/c)^2$], is 4×10^{-39} (5×10^{-38}) for charge (2/3) e ((1/3) e).

50695 Confirmation of the existence of the Σ/sub c/$^{++}$ and Λ/sub c/$^+$ charmed baryons and observation of the decay Λ/sub c/$^+ \rightarrow \Lambda\pi^+$ and K-bar^{0}p. Baltay, C.; Caroumbalis, D.; French, H.; Hibbs, M.; Hylton, R.; Kalelkar, M.; Shastri, K.; Vogel, A.; Cnops, A.M.; Connolly, P.L.; Kahn, S.A.; Kirk, H.G.; Murtagh, M.J.; Palmer, R.B.; Samios, N.P.; Tanaka, M. (Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **42**: No. 26, 1721-1724(25 Jun 1979).

In a broadband neutrino exposure of the Fermilab 15-ft bubble chamber, we observe the production of the Σ/sub c/$^{++}$(2426) charmed baryon followed by its decay to Λ/sub c/$^+$(2260) and π^+. We find the mass of the Λ/sub c/$^+$ to be 2257 +- 10 MeV and the m (Σ/sub c/$^{++}$) - m (Λ/sub c/$^+$) mass difference to be 168 +- 3 MeV. Previously unseen two-body decay modes of the Λ/sub c/$^+$(2260) are observed.

50696 Scattering of muons at 150 GeV. Wilson, R. (Harvard Univ., Cambridge, MA). pp 589-608 of New phenomena in subnuclear physics. Part B. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

The use of muons in similar ways to the use of electrons as probes of nucleon structure is considered. It is concluded that muon scattering has shown that scale invariance is not as simple as had been previously suggested. Problems and results of various experiments are noted. The hadron data has the potential of being more detailed than any data before, but thus far shows no surprises at higher energy. 12 references. (JFP)

50697 Recent results from the Caltech—Fermilab neutrino experiment. Barish, B.C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. pp 897-927 of New phenomena in subnuclear physics. Part B. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

A neutrino experiment was carried out in order to follow up the discovery of neutral currents. Both the strength of these currents and the nature of their couplings are studied. As a side product neutrino events with two muons in the final state were observed that appear due to new and as yet unexplained physics. The $\nu + N \rightarrow \mu$ + hadrons charged-current events were also studied, especially with antineutrinos, looking for any possible thresholds or anomalies. 12 references. (JFP)

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 50687, 50754

50698 (COO—3000-T1) Neutral particle production in diffractive pion—proton and proton—proton interactions at 147 GeV/c. Napier, A. (Massachusetts Inst. of Tech., Cambridge (USA)). 4 May 1979. Contract EY-76-C-02-3000. 184p. P 09/MF A01.

Thesis.

A 273,000 picture exposure of the Fermilab 30-Inch Hybrid Bubble Chamber Spectrometer was made to study π^+, K^+, and proton collisions with a proton target. A prototype lead glass gamma detector was used to determine energy and production angles of forward gamma rays and neutral pions. Single particle π^0 distributions were compared with π/sup +-/ distributions in π^+-proton and proton—proton events. Production of fast π^0 and π^- in the proton beam was strongly suppressed relative to that observed in the π^+ beam. Production of rho^0 and rho$^+$, associated with the π^+ beam, contributes to this effect. A sample of leading particle events was isolated by a selection procedure based on the kinematical configuration of all charged particles in the event. Cross sections, charge multiplicity distributions, and single particle distributions were obtained. The leading particle cross sections are predominantly diffractive, however, a decrease at higher energies is expected, due to PPR contributions in the context of a triple-Regge model. 71 references.

50699 Charged- and neutral-particle production from 400-GeV/c pp collisions. Kass, R.D.; Ko, W.; Lander, R.L.; Michael, W.; Pellett, D.E.; Yager, P.M.; Ely, R.; Gidal, G.; Hanson, P. (University of California, Davis, Davis, California 95616). *Phys. Rev., D;* **20**: No. 3, 605-614(1 Aug 1979).

Charged- and neutral-particle production from 400-GeV/c pp collisions are measured simultaneously using the Fermilab 15-ft bubble chamber. The π^0 and K^0 cross sections are rising at Fermilab energies, while the Λ^0 cross section remains fairly constant. Similarly, the average number of π^0's and K^0's increases as a function of the number of negative particles in an event, yet no such dependence is noted for the Λ^0's. The ratio of average number of π^0 to average number of π^- per inelastic collisions is found to be constant at Serpukhov and Fermilab energies (40 to 400 GeV/c) and equal to 1.22 +- 0.02. Cross sections for Σ^0 and Sigma-bar^0 production are measured and limits are found for eta^0 and ω^0 production. Neutral- and charged-pion correlations are compared with five pion-production models.

50700 Measurements of two- and three-spin parameters at 6 GeV/c using a transversely polarized beam and target. Beretvas, A.; Miller, D.; Auer, I.P.; Giese, R.; Hill, D.; Nield, K.; Rynes, P.; Sandler, B.; Watanabe, Y.; Yokosawa, A. (Northwestern University, Evanston, Illinois 60201). *Phys. Rev., D;* **20**: No. 1, 21-32(1 Jul 1979).

Toward the goal of experimentally determining pp elastic scattering amplitudes at 6 GeV/c, we have measured a linear combination of triple-spin correlation parameters and also a linear combination of spin-transfer parameters over the vertical-bart vertical-bar range between 0.2 and 1.0 $(GeV/c)^2$. A horizontally polarized beam (S direction) was obtained by precessing the spin of the polarized beam from the Argonne Zero Gradient Synchrotron using a superconducting solenoid. The target protons were polarized vertically (N direction) and the polarization of the recoil protons was measured with a carbon polarimeter. The results are consistent with the amplitude corresponding to π exchange being almost real and positive.

50701 Inclusive production of large-transverse-momentum hadrons and hadron pairs. Joestlein, H.; Engelmann, R.J.; Fisk, R.J.; Good, M.L.; Ito, A.S.; Kaplan, D.M.; Kephart, R.D.; McCarthy, R.L.; Wahl, H.; Herb, S.W.; Hom, D.C.; Lederman, L.M.; Sens, J.C.; Snyder, H.D.; Yoh, J.K.; Appel, J.A.; Brown, B.C.; Brown, C.N.; Innes, W.R.; Ueno, K. (State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev., D;* **20**: No. 1, 53-81(1 Jul 1979).

We have studied interactions of 200, 300, and 400 GeV protons with beryllium and tungsten targets, in which two large-p/sub t/ hadrons were produced roughly back-to-back near 90° in the proton-nucleon center-of-momentum system. Both hadrons could by identified. Some results from this work were published earlier. This paper describes properties of the apparatus, data on the two-particle correlation as a function of the kinematic variables and quantum numbers of the produced hadrons, invariant two-particle cross sections, and scaling properties of symmetric hadron-pair production.

50702 Studies of neutron dissociation at Fermilab energies. Ferbel, T. (Univ. of Rochester, NY). pp 663-702 of New phenomena in subnuclear physics. Part B. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

In summary, the characteristics were examined of diffraction dissociation of neutrons into $p\pi^-$ systems at high energies. A substantial correlation is observed between the mass and the t of the produced system. The spin structure of the $p\pi^-$ amplitudes at low mass is very complex, but is described surprisingly well by the

simple Deck mechanism. Both π-exchange and proton-exchange contributions are evident in diffractive production. The t-channel and s-channel helicity amplitudes contain comparable contributions from flip and non-flip terms and the produced states are not restricted to those expected on the basis of the Morrison rule.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 50698

50703 Properties of the psi resonances. Breidenbach, M. (Stanford Linear Accelerator Center, CA). pp 609-634 of New phenomena in subnuclear physics. Part B. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

Sharp peaks are seen in the electron—positron annihilation cross section corresponding to the psi at 3.095 GeV and the psi' at 3.684 GeV. Cross sections for the psi and psi' decay into hadrons, e^+e^- pairs, and $\mu^+\mu^-$ pairs are used to deduce the widths and quantum numbers of the psi and psi'. Studies of the decay modes are used to determine the G-parity of the psi and the existence of a two-pion cascade decay from the psi' to the psi. No other narrow resonances were found with masses between 3.2 and 7.6 GeV. 24 references.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

50704 New Phenomena in subnuclear physics. Part A. Zichichi, A. (ed.). New York, NY; Plenum Press (1977). 584p.

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

Separate abstracts were prepared for the 12 lectures presented. (JFP)

GENERAL

REFER ALSO TO CITATION(S) 50741

50705 Partial conservation of axial-vector current effects in the MIT bag model. Barnhill, M.V.; Cheng, W.K.; Halprin, A. (Physics Department, University of Delaware, Newark, Delaware 19711). *Phys. Rev., D;* **20**: No. 3, 727-730(1 Aug 1979).

We extend the calculations of the MIT-bag-model spectrum to include the pion-field exchange energy in a manner consistent with the ideas of partial conservation of axial-vector current. We find that this interaction energy is sufficient to destabilize the quark bag whose quantum numbers are those of the pion. The eta mass is also improved, while other features of the low-lying hadron mass spectrum are not significantly modified.

50706 Multiquark baryons and the MIT bag model. Strottman, D. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 3, 748-767(1 Aug 1979).

The calculation of masses of q^4q-bar and q^5q-bar^2 baryons is carried out within the framework of Jaffe's approximation to the MIT bag model. A general method for calculating the necessary $SU(6) \subset SU(3) \times SU(2)$ coupling coefficients is outlined and tables of the coefficients necessary for q^4q-bar and q^5q-bar^2 calculations are given. An expression giving the decay amplitude of an arbitrary multiquark state to arbitrary two-body final states is given in terms of SU(3) Racah and 9-$\lambda\mu$ recoupling coefficients. The decay probabilities for low-lying $1/2^-$ q^4q-bar baryons are given and compared with experiment. All low-lying $1/2^-$ baryons are found to belong to the same SU(6) representation and all known $1/2^-$ resonances below 1900 MeV may be accounted for without the necessity of introducing P-wave states. The masses of many exotic states are predicted including a $1/2^-$ Z^*_0 at 1650 MeV and $1/2^-$ hypercharge -2 and +3 states at 2.25 and 2.80 GeV, respectively. The agreement with experiment for the $3/2^-$ and $5/2^-$ baryons is less good. The lowest q^5q-bar^2 state is predicted to be a $1/2^+$ Λ^* at 1900 MeV.

50707 Static sources in classical Yang-Mills theory. Sikivie, P.; Weiss, N. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 2, 487-490(15 Jul 1979).

We examine initial-time Yang-Mills field configurations which satisfy Gauss's law in the presence of static external sources. We show that if such a configuration is an extremum of the energy, then it is a static solution of the Yang-Mills equations. Next we consider Yang-Mills field configurations which satisfy Gauss's law for one external point source. We show that there exists a large class of such configurations which have lower energy than the Coulomb solution.

50708 Are gluon jets oblate. Brodsky, S.J.; DeGrand, T.A.; Schwitters, R.F. (Stanford Linear Accelerator Center, CA (USA)). *Phys. Lett., B;* **79**: No. 3, 255-258(20 Nov 1978).

A model is considered for gluon jet fragmentation based on QCD in which the fast hadrons in the jet are produced by the sequential reaction gluon→qanti q→hadrons. The resulting jet shows an oblate transverse momentum structure, with a major axis preferentially oriented normally to the direction of linear polarization of the gluon. Jet-jet oblateness angular correlations in decays of heavy Qanti Q pseudoscalar and vector systems are discussed.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 50663, 50673, 50689, 50752

50709 (COO—1545-255) Jet angular distribution from quantum chromodynamics. Nandi, S.; Wada, W.W. (Ohio State Univ., Columbus (USA). Dept. of Physics). 27 Jun 1979. Contract EY-76-C-02-1545. 18p. P 02/MF A01.

The quantum chromodynamic correction to jet (defined a la Sterman and Weinberg) angular distribution in energetic e^+e^- annihilation is calculated to order α/sub s/ keeping exact dependence on ϵ and δ. Deviations from the zeroth order distribution, $1 + \cos^2\theta$, for are found relatively large values of ϵ and δ. This effect could be tested at the existing e^+e^- colliding beam facilities.

50710 Weak decay of heavy vector mesons. Rizzo, T.G. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **20**: No. 3, 713-716(1 Aug 1979).

We consider the possibility that weak decay may compete with or dominate electromagnetic decay of heavy vector mesons. We find that this possibility is realized for vector mesons containing t quarks (Q = 2/3) for m/sub t/ > 12 GeV if we use the mass-splitting formula of De Rujula et al. We further analyze the possible weak decay modes and find that annihilation contributions are suppressed by mixing angles for both the D^+/sub t/* (td-bar) and F^+/sub t/* (ts-bar). For the D^0/sub t/* (tu-bar) we find that the decay mode D^0/sub t/* → bd-bar may be significant depending on the value of m/sub t/ and the amount of nonleptonic enhancement.

50711 High-energy predictions in quantum chromodynamics. Gupta, S.; Mueller, A.H. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **20**: No. 1, 118-146(1 Jul 1979).

In this paper the methods of cut vertices are applied to deeply inelastic electron scattering, single-particle hadron production in e^+e^- annihilation, multiparticle inclusive production in e^+e^- annihilation, μ-pair production in hadron-hadron collisions, wide-angle inclusive hadron production in hadron-hadron collisions, and single-particle production in deeply inelastic electron scattering. A generalized Wilson expansion is discussed in detail for two-particle inclusive production in e^+e^- annihilation. The question of soft and wee partons is discussed and the cancellation of wee partons demonstrated. The relation of cut vertices to the parton model is briefly discussed.

50712 Tests of quantum chromodynamics in two-photon collisions and high-p/sub T/ photon production. Frazer, W.R.; Gunion, J.F. (University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **20**: No. 1, 147-165(1 Jul 1979).

We use the diagrammatic approach to scale breaking to rederive the results of the renormalization-group approach to two-photon, $\gamma^*\gamma$, collisions, where one of the photons is highly virtual and the other nearly real. In an axial gauge only ladder diagrams contribute to leading-logarithmic accuracy. When interpreted in terms of the quark distribution of the real photon we obtain the result G/sub q//γ(q^2,x) = [α/α/sub s/(q^2)]f/sub q/(x) + O (1), where f/sub q/(x) is an exactly calculable scaling function. By virtue of the fact that only ladder diagrams contribute in leading-logarithmic accuracy for this and other short-distance photon-target probes, we find that this form for G/sub q//γ can be employed (to leading-logarithmic accuracy) in any short-distance application involving a photon target. We give a summary of these additional applications with emphasis on high-transverse-momentum phenomena. We present also estimates of the vector-dominance background to the point-like component of the photon distribution function. In addition we present a convenient summary of leading-logarithmic quantum-chromodynamic corrections including dominant x → 1 behaviors.

50713 Higher-order asymptotic-freedon corrections to photon-photon scattering. Bardeen, W.A.; Buras, A.J. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **20**: No. 1, 166-178(1 Jul 1979).

We generalize Witten's calculation of the photon structure function F_2/sup \/ to the next-to-the-leading order of asymptotic freedom. Except for the second moment of F_2/sup \/, the result is

independent of the unknown matrix elements of quark and gluon operators between the photon states. The nonleading corrections turn out to be large.

WEAK INTERACTIONS

50714 Low-mass lepton pairs from hadron and neutrino beams. Goldman, T.; Duong-van, M.; Blankenbecler, R. (Lauritsen Laboratory, California Institute of Technology, Pasadena, California 91125). *Phys. Rev., D;* **20**: No. 3, 619-626(1 Aug 1979).

A simple model based on meson annihilation is proposed to explain low-mass production of lepton pairs for both hadron and neutrino beams. Resonances, such as the rho and ω, are naturally taken into account and are shown to give rise to a large but unexpected contribution at very low pair masses. Numerical results are given together with comparisons to data. For the most part, the normalizations are taken from other experimental data.

50715 Decays of heavy quarks. Rizzo, T.G. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **20**: No. 3, 706-712(1 Aug 1979).

The weak decay of heavy b and t quarks is discussed using the mixing angles obtained in Fritzsch's model. We find that the decay b → c dominates over b → u for 7 < or = m/sub t/ < or = 15 GeV by at least 2 to 1 and that the semileptonic branching ratio of b is ≅14%; the b-quark lifetime is ~1.6 x 10^{-13} sec for m/sub t/ ≅ 14 GeV. For t quarks of this mass we find tau/sub t/ < or ≅ 1.7 x 10^{-17} sec and B (t → Xμ⁺ ν/sub μ/) < or ≅ 12%, the equality holding for the absence of nonleptonic enhancement. b-quark cascade decay is found to be an insignificant source of multimuons in ν interactions and suitably small in nu-bar interactions, consistent with the data of the CERN-Dortmund-Heidelberg-Saclay and Harvard-Pennsylvania-Wisconsin-Fermilab collaborations. Several branching ratios for exotic final states produced via b quarks in e^+e^- annihilation are discussed.

50716 Evidence from very large transverse momenta of a change with temperature of velocity of sound in hadronic matter. Friedlander, E.M.; Weiner, R.M. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 1, 15-18(2 Jul 1979).

The most recent CERN intersecting storage-rings data on very large transverse momenta show that the velocity of sound in hadronic matter increases from ≅ 1√7 to ≅ 1√3.5, implying a phase transition from a strongly interacting (hadron) phase to a weakly interacting (parton?) phase.

50717 Weak effects in Σ^0 decay. Wolfram, S. (California Institute of Technology, Pasadena, California 91125). *Phys. Rev., D;* **20**: No. 1, 345(1 Jul 1979).

It is pointed out that weak interactions should admix a small parity-violating E1 component into the M1 electromagnetic decay $\Sigma^0 \rightarrow \Lambda\gamma$.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 50714, 50735, 50826

50718 Kinematics-free angular momentum trajectories. I. Theory and phenomenology. Leacock, R.A. (Ames Laboratory, United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **20**: No. 1, 305-315(1 Jul 1979).

In the main part of this paper it is shown how to define other complex angular momentum trajectories which are related to, but distinct from, the usual Regge trajectory α. One of these other trajectories, called here γ, is a zero of a function Y (which is essentially the cotangent of the scattering phase shift for physical values of the angular momentum) in contrast to the Regge trajectory α which is a zero of the inverse S matrix. γ has simpler analyticity properties as a function of energy than α. The γ trajectory is, in one sense, the α trajectory with the contribution of the elastic kinematics removed; thus γ is real between the elastic threshold and the inelastic threshold, unlike α. The ways by which γ and α produce bound states and elastic and inelastic resonances are compared and contrasted. One unusual feature of the γ trajectory is that it can be purely real and still produce resonances of finite width. In the secondary part of the paper the pion-nucleon elastic-phase-shift "data" of the P_{33} and F_{37} partial waves in the regions of the $P_{33}(1232)$ and $F_{37}(1950)$ resonances are given a direct-channel complex angular momentum interpretation using a crude model based on the γ trajectory. The model fitted to the data (1) provides an illustration of the use of the γ trajectory, and (2) demonstrates the feasibility of a direct-channel complex angular momentum analysis of scattering data.

50719 Kinematics-free angular momentum trajectories. II. Yukawa-potential numerical examples. Leacock, R.A.; Martin, R.L. (Ames Laboratory, United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **20**: No. 1, 316-325(1 Jul 1979).

The kinematics-free angular momentum trajectory, called the γ trajectory, is illustrated numerically in nonrelativistic potential scattering using Yukawa and exponential potentials of various strengths. The γ trajectory, in contrast to the α (Regge) trajectory, is free of elastic kinematics and so is real for all energies above threshold and real for certain energies below threshold. Resonances are caused when the γ trajectory passes through the resonance angular momentum at the resonance energy, and bound states are caused when the γ trajectory passes near the bound-state angular momentum at the bound-state energy. Numerical illustrations of the following γ trajectory characteristics are given: the reality of γ, bound-state and resonance production, threshold and high-energy behavior, and collisions of trajectories below threshold. In addition, general properties of γ trajectories in the context of potential scattering are discussed.

50720 Quark confinement schemes in field theory. Drell, S.D. (Stanford Linear Accelerator Center, CA). pp 143-191 of New phenomena in subnuclear physics. Part A. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

The treatment of quark confinement in field theory primarily concerns the bag models derived from canonical field theory which reproduced a number of the successful naive quark model results and which provides a basis for additional speculations. Also work is described in which the self-coupled neutral scalar boson field on a lattice is formulated, and the quantum behavior and spontaneous symmetry breaking is studied using a variational method for bounding the energy from above. 13 references. (JFP)

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 50722

50721 (LA-UR—79-1423) **Bounds on the weak meson-nucleon couplings from parity violating effects in nonleptonic nuclear processes.** Bowman, J.D.; Gibson, B.F.; Herczeg, P.; Henley, E.M. (Los Alamos Scientific Lab., NM (USA); Washington Univ., Seattle (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-790648—4). P 02/MF A01.

From Neutrino 1979 conference; Bergen, Norway (18 Jun 1979).

The implications of the existing experimental and theoretical information on the p.v. meson-nucleon coupling constants are investigated. 9 references.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 50721, 50732

50722 (BNL—26444) **Cosmological limits on the existence of possible stable heavy hadrons.** Dover, C.B.; Gaisser, T.K.; Steigman, G. (Pennsylvania Univ., Philadelphia (USA); Princeton Univ., NJ (USA); Delaware Univ., Newark (USA)). 1979. Contract EY-76-C-02-0016. 14p. (CONF-790836—2). P 02/MF A01.

From 16. international cosmic rays conference; Kyoto, Japan (6 Aug 1979).

With regard to cosmological limits on the existence of possible stable heavy hadrons, it is considered what are the quantum numbers of the least massive hadrons which can be formed with the new quarks (stable quarks with lifetime on the scale of $4(10)^9$ years), the possible binding of these heavy new hadrons to single nucleons, forming a system analogous to the deuteron. The approximate binding energy of a new hadron to a heavy nucleus, possible predictions for the abundance of such objects, and what experiments would be most likely to reveal their presence and what are the current experimental limits on the abundance of such nuclei are also treated. 13 references. (JFP)

50723 Special coherent states for π-N scattering. Bolsterli, M. (Los Alamos Scientific Lab., NM (USA). Theoretical Div.). pp 65-66 of Few body systems and nuclear forces. Pt. 1. Zingl, H.; Haftel, M.; Zankel, H. (eds.) (Graz Univ. (Austria). Inst. fuer Theoretische Physik). Berlin, Germany, F.R.; Springer (1978).

From Conference on few body systems and nuclear forces; Graz, Austria (24 Aug 1978).

The static model for pion-nucleon interaction provides a basis for understanding p-wave pion-nucleon scattering phase shifts. That reasonable phase shifts can be computed by using the dispersion method of Chew and Low is well known; the direct method used by Friedman, Lee, and Christian (FLC) to obtain equally interesting phase shifts is less well known. Recent work has clarified the connection between static and nonstatic models for meson-nucleon interaction: For weak coupling the static model is unrelated to a

corresponding nonstatic model, but for strong coupling the static model solutions are a useful first step toward constructing solutions of the corresponding nonstatic model.

50724 Weak exchange degeneracy in the reactions $\pi^+ p \to K^+ \Sigma^+$ and $K^- p \to \pi^- \Sigma^+$ at 4, 7, 11.5, and 70 GeV/c. Ward, B.F.L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 3, 683-691(1 Aug 1979).

The existing data on the line-reversed reactions $\pi^+ p \to K^+ \Sigma^+$ and $K^- p \to \pi^- \Sigma^+$ near 4, 7, and 11.5 GeV/c are discussed from the point of view of weak exchange degeneracy (WEXD). It is noted that a smooth and simple generalization of the model of Navelet and Stevens is able to describe adequately, in the Regge region, the data at 7 and 11.5 GeV/c. (Recall that the Navelet and Stevens model appears to fit the pronounced violation of WEXD for leading K/sup asterisk/ and K/sup asteriskasterisk/ exchanges in the data near 4 GeV/c whereas the data at 7 and 11.5 GeV/c are in agreement with this particular WEXD.) A prediction for 70 GeV/c (namely, essentially that WEXD for leading K/sup asterisk/ and K/sup asteriskasterisk/ exchanges should hold true) is given. Further, an effort is made to indicate how this particular generalization of the model of Navelet and Stevens may arise in a dual multiperipheral bootstrap model of the general Lee-Veneziano-Chan-Paton variety as formulated by Balazs.

50725 Production of real photons at large transverse momentum in πp collisions. Jones, D.; Rueckl, R. (Department of Physics, University of California, Davis, California 95616). *Phys. Rev., D;* **20**: No. 1, 232-242(1 Jul 1979).

The production of photons at large transverse momentum can be used as a direct probe of the short-distance dynamics of hadronic collisions. We calculate the cross section for high-p/sub T/ photons produced in πp collisions from lowest-order quantum-chromodynamics (QCD) and higher-order constituent-interchange-model (CIM) processes. We investigate characteristic features of the QCD and CIM contributions, respectively, and discuss the experimental indicators of the presence of CIM contributions. We emphasize the frequent production of single-photon jets.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 50752

50726 (BNL—50885, pp 438-440) **Angular distributions for leptons from W mesons.** Paige, F.E. (Brookhaven National Lab., Upton, NY). Feb 1979.

In Proceedings of the 1978 ISABELLE summer workshop, Upton, New York, July 17—28, 1978.

Several members of the facilities subgroup at this Summer Study wished to have additional angular distributions for leptons coming from W mesons. These are calculated here by using the model (and computer program) of Peierls, Trueman, and Wang.

50727 Pseudoscalar-pseudovector equivalence of threshold production and absorption of pions. Noble, J.V. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev. Lett.;* **43**: No. 2, 100-103(9 Jul 1979).

If one compares pseudoscalar-coupled and pseudovector-coupled theories of the πNN interaction, which incorporate the restrictions of partial conservation of axial-vector current and realistic nuclear dynamics, then the amplitudes for exclusive (p,π^+) or (π^-,n) become identical, to $O(G^3)$.

50728 Diffractive dissociation using nuclear targets. Biel, J.; Ferbel, T.; Ford, W.; Golding, L.; Mollet, W.; Slattery, P.; Underwood, D.; Gobbi, B.; Kenah, L.; Rosen, J.; Ruchti, R.; Bleser, E.; Freytag, D. (University of Rochester, Rochester, New York 14627). *Phys. Rev., D;* **20**: No. 1, 33-36(1 Jul 1979).

We have compared our data for nuclear coherent dissociation of neutrons into $(p\pi^-)$ systems with a production model which was used previously to investigate the nature of the diffractive process on a hydrogen target. The decay and production characteristics observed for $(p\pi^-)$ systems produced on nuclear targets at Fermilab energies are in qualitative agreement with the predictions of the model.

50729 Constituent description of NN elastic scattering observables at large angles. Farrar, G.R.; Gottlieb, S.; Sivers, D.; Thomas, G.H. (California Institute of Technology, Lauritsen Laboratory of Physics, Pasadena, California 90024). *Phys. Rev., D;* **20**: No. 1, 202-210(1 Jul 1979).

We suggest that the constituent picture of nucleon-nucleon elastic scattering can be tested by the spin-correlation measurements A/sub l/l, A/sub s/s, A/sub n/n, and A/sub s/l. These measurements provide a means for isolating various reaction mechanisms, including possible quantum-chromodynamic instanton effects. We give specific model calculations to illustrate these ideas.

50730 Fast-meson production and the recombination model. Takasugi, E.; Tata, X.; Chiu, C.B.; Kaul, R. (Center for Particle Theory, Department of Physics, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **20**: No. 1, 211-220(1 Jul 1979).

Multiquark structure functions for the proton have been formulated assuming a statistical distribution of sea partons as in the Kuti-Weisskopf model. An alternative form for the recombination function has been obtained by imposing a cutoff on the rapidity gap of combining quarks. These multiquark structure functions and the recombination function have been used, within the framework of the recombination model of Das and Hwa, to discuss single-meson inclusive distributions, in the fragmentation region of the proton, in p-p collisions.

50731 Interpretation of p-p dibaryon resonances at 2140, 2260, and 2430 MeV. MacGregor, M.H. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev. Lett.;* **42**: No. 26, 1724-1728(25 Jun 1979).

Recent elastic p-p C/sub L/L measurements and other p-p data indicate the existence of $^1D_2$, $^3F_3$, and $^1G_4$ resonances at energies of about 2140, 2260, and 2430 MeV, respectively. These resonances accurately correspond to nuclear-physics—type rotational levels of a virtual $pp\pi$ (2020) bound state.

50732 Chiral symmetry and the nucleon—nucleon interaction. Brown, G.E. (State Univ., Stony Brook, NY). pp 329-356 of Mesons in nuclei. Volume I. Rho, M.; Wilkinson, D. (eds.). New York, NY; North-Holland Publishing Co. (1979).

The treatment covers the construction of the (π,α) four-vector, the sigma model, pion—nucleon scattering, derivative couplings, application to the nucleon—nucleon interaction, and many-body forces. Emphasis is placed on the isospin-averaged pion—nucleon scattering amplitude because of the important role played by it in the nucleon—nucleon interaction. 22 references. (JFP)

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

50733 Static Yang-Mills fields with sources. Jackiw, R.; Jacobs, L.; Rebbi, C. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **20**: No. 2, 474-486(15 Jul 1979).

Yang-Mills theory with a static, c-number external charge density is studied. Time-independent, non-Coulombic solutions are found for a wide variety of sources with arbitrary strength. Their energy as a function of source strength is lower than the Coulomb energy; moreover, the multiplicity of solutions increases when the source strength exceeds a critical magnitude. Intrinsically nonperturbative configurations that satisfy the field equations are presented. The quantal significance of these results is briefly discussed.

50734 U(1) as the minimal horizontal gauge symmetry. Davidson, A.; Koca, M.; Wali, K.C. (Physics Department, Syracuse University, Syracuse, New York 13210). *Phys. Rev. Lett.;* **43**: No. 2, 92-96(9 Jul 1979).

A horizontal U' (1) gauge symmetry is proposed to distinguish two fermionic generations. By extending the notion of generation structure to the Higgs system, and using anomaly-free conditions with the requirements of lepton-number conservation and proper Cabibbo structure, we determine Y' associated with U' (1), uniquely. The model can easily be generalized to account for 2/sup N/ (N = 1,2,...) generations.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

50735 (COO—1545-256) **SU(N) grand unification with several quark—lepton generations.** Frampton, P.H. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1979. Contract EY-76-C-02-1545. 7p. P 02/MF A01.

Procedures are given for embedding SU(5) into SU(N) such that several SU(5) generations remain as ordinary-mass fermions. Examples with an arbitrary number of generations occur already for SU(7). All models have only quarks and leptons, without quixes or quaights.

50736 Weak-interaction singlet and strong CP invariance. Kim, J.E. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). *Phys. Rev. Lett.;* **43**: No. 2, 103-107(9 Jul 1979).

Strong CP invariance is automatically preserved by a spontaneously broken chiral $U(1)_A$ symmetry. A weak-interaction singlet heavy quark Q, a new scalar meson σ^0, and a very light axion are predicted. Phenomenological implications are also included.

50737 Superweak gauge theory of CP-invariance violation. Barr, S.; Langacker, P. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). *Phys. Rev. Lett.;* **42**: No. 25, 1654-1658(18 Jun 1979).

We describe an extension of the Weinberg-Salam model to the group SU(2) x U(1) x U(1) ' in which CP invariance is spontaneously broken and physical CP-invariance violation is mediated by the new massive Z' boson.

APPLICATIONS TO STRONG INTERACTIONS

REFER ALSO TO CITATION(S) 50650, 50735, 50739

50738 Phenomenological constraints on broken supersymmetry. Goldman, T. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **78**: No. 1, 110-115(11 Sep 1978).

It is shown that the existence of massless color octet quarks, which appear in a class of broken supersymmetric field theories, implies the existence of additional light (< approximately 1 GeV) unstable hadrons with large (> approximately 10 μb) production cross sections. The half-life for these states is estimated to be less than 10^{-9}s. If it is greater than 10^{-10}s, these states are already ruled out experimentally.

FIELD THEORY

REFER ALSO TO CITATION(S) 50708, 50720

50739 (LBL—9022) Vector current scattering in two dimensional quantum chromodynamics. Fleishon, N.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 135p. P 07/MF A01.

Thesis.

The interaction of vector currents with hadrons is considered in a two dimensional SU(N) color gauge theory coupled to fermions in leading order in an N^{-1} expansion. After giving a detailed review of the model, various transition matrix elements of one and two vector currents between hadronic states were considered. A pattern is established whereby the low mass currents interact via meson dominance and the highly virtual currents interact via bare quark-current couplings. This pattern is especially evident in the hadronic contribution to inelastic Compton scattering, M/sub μν/ = ∫ dx e/sup iq.x/ < n vertical bar T*(J/sub μ/(x)J/sub ν/(0)) vertical bar m >, which is investigated in various kinematic limits. It is shown that in the dual Regge region of soft processes the currents interact as purely hadronic systems. Modification of dimensional counting rules is indicated by a study of a large angle scattering analog. In several hard inclusive nonlight cone processes, parton model ideas are confirmed. The impulse approximation is valid in a Bjorken—Paschos-like limit with very virtual currents. A Drell—Yan type annihilation mechanism is found in photoproduction of massive lepton pairs, leading to identification of a parton wave function for the current. 56 references.

50740 Reggeization of gauge vector mesons and unified theories. Grisaru, M.T.; Schnitzer, H.J. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *Phys. Rev., D;* **20**: No. 3, 784-793(1 Aug 1979).

An arbitrary, renormalizable non-Abelian gauge theory with gauge group G, and arbitrary scalar and fermion representation structure is considered. It is shown that all the gauge vector mesons of the theory lie on a Regge trajectory if and only if G is semisimple, i.e., Abelian subgroups are excluded. Implications for unified and grand unified theories of the weak and electromagnetic interactions are discussed. The photon, which does not Reggeize in the Weinberg-Salam theory, will lie on a Regge trajectory in a grand unified theory. If the Higgs-meson mass of the electroweak theory is large (> or ≃ 300 GeV, say), then Regge recurrences of the intermediate vector bosons should occur at energies of the order of 2—4 TeV. If the Higgs boson of the unified theory is light (< 100 GeV), then Regge recurrences of the gauge mesons are not expected for energies below the grand-unification mass of order μ/sub W//sup ts2/ exp(1/g^2).

50741 Classical, cross-section-generating solutions of field equations. Suranyi, P. (Blackett Laboratory, Imperial College, London SW7 2AZ, England). *J. Math. Phys. (N.Y.);* **20**: No. 8, 1720-1726(Aug 1979).

The symmetry properties of classical, cross-section generating solutions of field equations, sectons, are investigated. It is shown that under general conditions on the interaction Lagrangian of the field theory the symmetry group of the solutions can only be 0(1,1) x 0(2) for finite momenta. Such solutions generate inclusive cross sections with Feynman scaling.

50742 General mass formula in broken supersymmetry. Ferrara, S.; Girardello, L.; Palumbo, F. (Laboratori Nazionali di Frascati, Istituto Nazionale di Fisica Nucleare, Frascati, Italy). *Phys. Rev., D;* **20**: No. 2, 403-408(15 Jul 1979).

The mass formula summation/sub J/(- 1)/sup 2J/(2J + 1) m/sub J/ ^{2} = 0 is derived for a very general class of interactions with spontaneously broken supersymmetry. It shows the vanishing of the graded trace of the square of the mass operator, with m/sub J/ the mass associated with a (real) field of spin J. This mass relation is shown to be true even in the presence of explicit breaking, provided it fulfills suitable requirements.

50743 Singular classical solutions of Euclidean field theories. Butera, P.; Cicuta, G.M.; Enriotti, M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 2, 456-461(15 Jul 1979).

The classical solutions of the equations of motion are studied in some Euclidean field theory models either conformal invariant or noninvariant. In the conformal-invariant models a virial theorem for merons is derived which is of the same form as the known one for instantons. Some examples of singular solutions are discussed. An interesting relation seems to hold between the local symmetry properties of the singular solutions and the degree of divergence of the Euclidean action.

50744 Improved formalism for Abelian magnetic monopoles. Banks, T.; Tomboulis, E. (Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **20**: No. 2, 501-504(15 Jul 1979).

Euclidean lattice methods are used to derive an improved version of the Schwinger-Zwanziger Lagrangian for magnetic monopoles. The formalism involves a nondynamical string variable x/sub μ/(σ,tau). When the monopoles are coupled to a charged scalar field, x/sub μ/ can be utilized to absorb the dynamics of discontinuities in the angular part of the scalar field. In the Higgs phase where such discontinuities have finite action, x/sub μ/ becomes a dynamical variable and the Lagrangian becomes manifestly covariant. We derive the heuristic string-monopole equations of Nambu as the classical limit of the Higgs model in the London approximation.

50745 Equipartitioned jets: New tests of quantum chromodynamics. Marciano, W.J.; Wyler, D.; Parsa, Z. (The Rockefeller University, New York, New York 10021). *Phys. Rev. Lett.;* **43**: No. 1, 22-26(2 Jul 1979).

We propose a modified definition of hadronic jets in quantum chromodynamics which is more selective than the Sterman-Weinberg criterion. It prohibits any two jet streams from having appreciably different energies. Our more restrictive definition provides new tests of quantum chromodynamics in high-energy experiments. We illustrate this idea for two-"quark"-jet configurations in $e^+e^- \rightarrow$ hadrons and for two-"gluon"-jet production. The necessity of exponentiating perturbative jet predictions is also discussed.

50746 Nonperturbative determination of α (q^2) and its experimental implications. Sanda, A.I. (The Rockefeller University, New York, New York 10021). *Phys. Rev. Lett.;* **42**: No. 25, 1658-1661(18 Jun 1979).

The lowest-order perturbative expression for α (q^2), the quantum-chromodynamic running coupling constant, is inadequate for describing the moments of nucleon structure functions at present energies. I propose to determine α (q^2) with use of a new Borel-like summation technique described by Khuri. The α (q^2) which emerges from this procedure is free of the Landau ghost and it is consistent with experiments in both spacelike and timelike regions.

50747 Hamiltonian field theory for systems of nucleons and mesons. Bolsterli, M. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico). *Adv. Nucl. Phys.;* **11**: No. 1, 367-415(Jun 1979).

The covariant Hamiltonian used in polaron theory is analyzed. (AIP)

50748 Quantum electrodynamics in the temporal gauge. Creutz, M. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Ann. Phys. (N.Y.);* **117**: No. 2, 471-483(Feb 1979).

We canonically quantize electrodybamics in the temporal gauge $A_0 = 0$. Realizing commutation relations in a Hilbert space containing unphysical longitudinal photons, we pay special attention to the implementation of Gauss's law and the attendant normalization difficulties for physical states. We tehn formulate the perturbation series and explixitly exhibit equivalence with the standard textbook treatment of the Coulomb gauge.

50749 Relationship between gauge field theories and dual resonance models. Frampton, P.H. (Syracuse Univ., NY). pp 493-532 of New phenomena in subnuclear physics. Part A. Zichichi, A. (ed.). New York, NY; Plenum Press (1977).

From Proceedings of the 1975 International School of Subnuclear Physics (NATO-MPI-MRST Advanced Study Institute); Erice, Sicily (11 Jul 1975).

The connections are listed that are understood and well established, and those questions which are most likely to be fruitful to pursue further are indicated in this treatment of gauge field theories and dual resonance models relations. Relations in the direction of gauge theories to dual models are the reggeization of elementary particles in gauge theories, the lattice approach to gauge theories, classical vortex solutions of strong-coupled gauge theories, and the Coleman Sine—Gordon/Thirring duality as a quantum mechanical example where strong coupling may be sensible. Relations of dual models to gauge theories are then briefly discussed. The more obvious outstanding but possibly tractable questions are listed. 57 references. (JFP)

50750 Persistent self interactions in sine Gordon theory. Burt, P.B. (Stanford Linear Accelerator Center, CA (USA); Stanford Univ., CA (USA)); Mesgun, S. (North Carolina State Univ., Raleigh (USA). Dept. of Physics). *Acta Phys. Pol., B;* **7**: No. 10, 729-734(1976).

The sine Gordon field in 3+1 dimensions is studied as an example of a quantum field theory with persistent self interactions. Exact, positive or negative frequency (solitary wave) solutions of the sine Gordon equation containing either kannihilation or creation operators of the linear field theory are discussed. The sine Gordon solitary wave propagator closely resembles the solitary wave propagator of the lambda PHI^4 theory.

SCATTERING THEORY

REFER ALSO TO CITATION(S) 50749, 50816

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

50751 1978 recent references. Ewbank, W.B.; Haese, R.L.; Hurley, F.W.; McGinnis, M.R.; Ramavataram, S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **26**: No. 4, 525-778(Apr 1979).

References, key words, key numbers, and reaction indexing are given for all literature received by the Nuclear Data Project or assigned key numbers during 1978. (AIP)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

MOMENTS AND SPIN

50752 Mesonic vs relativistic effects. Friar, J.L. (Los Alamos Scientific Lab., NM). Contract E(11-1)-3235;W-7405-ENG-36. pp 595-624 of Mesons in nuclei. Volume II. Rho, M.; Wilkinson, D. (eds.). New York, NY; North-Holland Publishing Co. (1979).

Emphasis is placed on calculations of the contribution to the magnetic moment of the deuteron of order $1/m^3$ from vector and scalar meson exchange and contributions to the charge density from pion exchange of order $1/m^2$ with emphasis on the deuteron problem. The discussion of both problems allows a development of the connection between various aspects of relativity and exchange effects, and in particular the connection between the nuclear potential and exchange currents and charge. Retardation, energy-dependent potentials, recoil graphs, relativistic center-of-mass motion, and the pion-exchange charge operator. 80 references. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

50753 (COO—2232A-70) **Production of π^{+-}, K^{+-}, p, and anti p by 400 GeV/c protons.** Baker, W.F.; Carroll, A.S.; Chiang, I.H. (Brookhaven National Lab., Upton, NY (USA); Fermi National Accelerator Lab., Batavia, IL (USA); Rockefeller Univ., New York (USA)). Oct 1978. Contract EY-76-C-02-2232. 9p. (FERMILAB—78/79-EXP). P 02/MF A01.

Data are presented on the relative yields of π^{+-}, K^{+-}, p and anti p with momenta between 60 and 370 GeV/c produced at forward angles by 400 GeV/c protons incident on a beryllium target.

50754 nd backward scattering from 200 to 800 MeV. Bonner, B.E. (Los Alamos Scientific Lab., NM (USA)); Glass, G. (Texas A and M Univ., College Station (USA)); Hollas, C.L.; Newsom, C.R.; Riley, P.J. (Texas Univ., Austin (USA)). pp 195-196 of Few body systems and nuclear forces. Pt. 1. Zingl, H.; Haftel, M.; Zankel, H. (eds.) (Graz Univ. (Austria). Inst. fuer Theoretische Physik). Berlin, Germany, F.R.; Springer (1978).

From Conference on few body systems and nuclear forces; Graz, Austria (24 Aug 1978).

All previous measurements of Nd scattering above 150 MeV have utilized either proton or deuteron beams with the exception of a single 800-MeV measurement. We have recently completed the analysis of an experiment using a continuum neutron beam incident on a deuterium target in which recoil deuterons were detected at laboratory angles from 0° to 20°, corresponding to neutron center-of-mass angles from 140° to 180°. Preliminary results for the extreme back angle (thetasub(n)* > 175°) measurements have been reported and details of the experimental setup are given therein. We report here on the energy and angular variation of the nd elastic scattering cross section for angles 140° to 180° c.m. and energies 200 to 800 MeV.

50755 Lifetimes of the ^{21}Ne 2796-, 1747-, and 2867-keV levels. Warburton, E.K.; Olness, J.W.; Lister, C.J. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **20**: No. 2, 619-640(Aug 1979).

The mean lives of the ^{21}Ne $1/2^+$, $7/2^+$, and $9/2^+$ levels at 2796, 1747, and 2867 keV have been measured using the ^{4}He(^{18}O,n)^{21}Ne reaction near threshold and the Doppler shift attenuation method. The results were 7.9 +- 1.0, 74 +- 6, and 61 +- 6 fs, respectively. In order to obtain a result for the 8-fs 2796-keV level, four different targets were used. These consisted of ^{4}He implanted in thick backings of Mg, Al, Ta, and Au. The analysis developed for measuring this fast lifetime is described in detail. Excitation energies of 1747.2 +- 0.3, 2788.87 +- 0.10, 2795.8 +- 0.7, and 2867.2 +- 0.4 keV were obtained for the second-to-fifth excited states. The lifetime results are compared to recent shell-model predictions.

50756 p+^{3}He elastic scattering from 18 to 48 MeV. Brown, R.E. (Los Alamos Scientific Lab., NM (USA)); Murdoch, B.T.; Hasell, D.K.; Sourkes, A.M.; Van Oers, W.T.H. (Manitoba Univ., Winnipeg (Canada)). pp 292-293 of Few body systems and nuclear forces. Pt. 1. Zingl, H.; Haftel, M.; Zankel, H. (eds.) (Graz Univ. (Austria). Inst. fuer Theoretische Physik). Berlin, Germany, F.R.; Springer (1978).

From Conference on few body systems and nuclear forces; Graz, Austria (24 Aug 1978).

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

50757 Isospin mixing in ^{19}F. Lawson, R.D. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **20**: No. 2, 842-844(Aug 1979).

Isospin mixing in the yrast I = $5/2^+$ T = 1/2 level has been calculated assuming an isoscalar nucleon-nucleon interaction and the single-particle level spacings observed in ^{17}O and ^{17}F. Results are presented for both the (d/sub 5/2/,s/sub 1/2/) and two variants of the (d/sub 5/2/,s/sub 1/2/,d/sub 3/2/) model spaces. The experimental value does not require the introduction of a charge symmetry or charge independence breaking nucleon-nucleon interaction.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50797

50758 Time-dependent Hartree-Fock calculations of fusion cross sections for ^{16}O + ^{40}Ca and ^{28}Si + ^{28}Si. Bonche, P.; Davies, K.T.R.; Flanders, B.; Flocard, H.; Grammaticos, B.; Koonin, S.E.; Krieger, S.J.; Weiss, M.S. (Service de Physique Theorique, CEN Saclay, BP n°2, 91190 Gif-sur-Yvette, France). *Phys. Rev., C;* **20**: No. 2, 641-647(Aug 1979).

Time-dependent Hartree-Fock calculations are carried out for the systems ^{16}O + ^{40}Ca and ^{28}Si + ^{28}Si. Cross sections for the formation of ^{56}Ni are qualitatively similar in both cases, although there exist significant quantitative differences which reflect the importance of the entrance channel. Both systems exhibit an angular momentum window for fusion. The results of the calculations are compared with currently available experimental data.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 50424

ENERGY LEVELS AND TRANSITIONS

50759 **$^{13}C + ^{13}C$ transfer reactions at 93.8 MeV.** Fulmer, C.B.; Wieland, R.M.; Hensley, D.C.; Raman, S.; Satchler, G.R.; Snell, A.H.; Stelson, P.H.; Stokstad, R.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 670-682(Aug 1979).

Angular distributions of the most intense one- and two-nucleon transfer reactions induced by 93.8 MeV ^{12}C ions on a ^{12}C target were measured over the angular range 10—65°. The reactions are selective in that only a few of the available states are strongly excited. For both single proton and single neutron transfer, p/sub 1/ 2/ and d/sub 5/2/ shells are populated with about equal probability; for pn transfer the strongest peak corresponds to the 5^+ level of ^{14}N. The sum of the cross sections for all of these transfer reactions, integrated over the measured angular range, is 7.5 mb. This may be compared with 45 mb for the inelastic scattering to the 2^+ level of ^{12}C and 14 mb for mutual excitation of the 2^+ level in the target and projectile. Distorted-wave Born-approximation calculations are compared with the measured angular distributions for a number of the transfer reactions.

NUCLEAR REACTIONS AND SCATTERING

50760 **Heavy ion radiative capture cross sections.** Viano, J.B.; Cole, A.J.; Longequeue, N.; Lucas, J.J.; Menet, J.; Saulnier, J.C.; Sunier, J.W. (Institut des Sciences Nucleaires (IN2P3 - USMG), 53, avenue des Martyrs, F, 38026 Grenoble Cedex, France). *Phys. Rev., C;* **20**: No. 2, 551-555(Aug 1979).

Cross sections for the radiative capture and one nucleon emission reactions have been obtained by mass identification of reaction products at 0° using thin targets for the systems $^{12}C + ^{14}N$ (70 and 59 MeV), $^{30}Si + ^{14}N$ (70 and 59 MeV) and $^{27}Al + ^{14}N$ (59 MeV). The cross sections for radiative capture are in all cases $<$ 500 nb. The measurement of the $^{30}Si + ^{14}N$ cross section is in disagreement with previous work performed using thick targets. This discrepancy is discussed.

50761 **Elastic and inelastic scattering of ^{12}C by ^{12}C from E/sub c.m./ = 35—63 MeV.** Stokstad, R.G.; Wieland, R.M.; Satchler, G.R.; Fulmer, C.B.; Hensley, D.C.; Raman, S.; Rickertsen, L.D.; Snell, A.H.; Stelson, P.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 655-669(Aug 1979).

Differential cross sections for the elastic scattering, single excitation (Q = -4.43 MeV), and mutual excitation (Q = -8.86 MeV) of ^{12}C by ^{12}C have been measured at 14 bombarding energies in the range E/sub c.m./ = 35—63 MeV. The angular distributions extend typically from 16° to 90° c.m. The results have been analyzed with the optical model, the distorted-wave approximation, and the method of coupled equations. The optical model analysis of the elastic scattering reveals a sensitivity of the predicted cross sections at large angles to the strength and shape of the real part of the nuclear potential in the region 4 to 6 fm. The potentials predicted by the double-folding model fit the data remarkably well over the entire angular range, whereas the shallow potentials which we have explored generally fit the data only in the forward-angle region. The results thus indicate that the real potential for the $^{12}C + ^{12}C$ system is more attractive in the region of 4 to 6 fm than would have been expected on the basis of previous analyses of comparable systems at lower bombarding energies.

50762 **^{7}Be production cross sections in N, C, ^{11}B, and ^{10}B with 740 MeV protons.** Radin, J.R.; Gradsztajn, E.; Smith, A.R. (Tel Aviv University, Department of Physics and Astronomy, Ramat Aviv, Israel). *Phys. Rev., C;* **20**: No. 2, 787-792(Aug 1979).

A fundamental problem in cosmic-ray physics is the production and propagation of Be. We have measured the cross section at 740 MeV for ^{7}Be production in N(10.9 mb +- 6%), C(9.82 mb +- 6%), ^{11}B(4.17 mb +- 7%), and ^{10}B(6.28 mb +- 7%). The monitor reactions were C(p,x) ^{11}C = 29.9 mb +- 5% and the C(p,x)^{7}Be cross section listed above.

50763 **Comparison of fusion cross sections for $^{10}B + ^{16}O \rightarrow ^{26}Al$ and $^{12}C + ^{14}N \rightarrow ^{26}Al$.** Gomez del Campo, J.; Dayras, R.A.; Biggerstaff, J.A.; Shapira, D.; Snell, A.H.; Stelson, P.H.; Stokstad, R.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **43**: No. 1, 26-29(2 Jul 1979).

The cross section for fusion of $^{10}B + ^{16}O$ is found to differ markedly from that of $^{12}C + ^{14}N$ for bombarding energies in the range 3 to 9 times the fusion barrier. This difference exceeds that expected on the basis of calculated or measured nuclear density distributions for these nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

50764 **$\Delta T = 1$, $0^+ \rightarrow 0^+$ beta decay of ^{28}Mg.** Alburger, D.E.; Warburton, E.K. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **20**: No. 2, 793-798(Aug 1979).

The isospin-forbidden beta-decay branching ratio of the 0^+, T = 2 ^{28}Mg ground state to the 972-keV 0^+, T = 1 level of ^{28}Al is measured to be (0.31 +- 0.04) % corresponding to ft = (9.20 +- 1.1) x 10^7, logft = 7.96 +- 0.06. A charge-dependent matrix element between the 0^+, T = 2 analog state at 5992 keV in ^{28}Al and the anti-analog level at 972 keV of 20.6 +- 1.6 keV is deduced from this branching ratio. This is in good agreement with a previous result.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50695

50765 **^{16}O scattering from the even-A Mg and Si isotopes.** Fortune, H.T.; Richter, A.; Siemssen, R.H.; Yntema, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **20**: No. 2, 648-654(Aug 1979).

Excitation functions for ^{16}O elastic scattering were measured for /sup 24,26/Mg and /sup 28,30/Si at several angles in the energy range 20 MeV $<$ or $\approx$ E/sub c.m./ $<$ or $\approx$ 35 MeV. Detailed angular distributions were obtained for ^{24}Mg (^{26}Mg) at E/sub c.m./ = 21 (21.7), 24 (24.8), 27 (27.9), and 30 (31.0) MeV. The data were analyzed with a conventional optical model with a shallow, and energy-dependent real, and a weakly absorbing and energy-dependent imaginary potential.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

50766 **Shell structure of collective states in ^{56}Fe, ^{58}Fe, and ^{60}Fe.** McGrory, J.B.; Raman, S. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 830-841(Aug 1979).

Conventional shell-model calculations of the iron isotopes with A = 56—60 are discussed. The calculated level spectra are in good agreement with experiment. The calculations of E2 observables are in reasonable agreement with experiment when added effective charges of 1.0e are used for both neutrons and protons. The neutron effective charge is significantly different from one appropriate (1.9e) for ^{56}Ni. There is a strong state dependence in the effective M1 operator, and calculations of M1 observables are in general disagreement with experiment. An analysis of the structure of ground-state bands and yrast levels is made in terms of a simple rotational model. In all even isotopes, the intrinsic quadrupole moments in the ground-state "band" shrink dramatically with increasing J. There is evidence of a band crossing in all three even isotopes, but no evidence is found for an abrupt shape change in the ground-state bands of these nuclei. It is concluded that no simple rotational model gives a good description of the low-lying states of the iron isotopes.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 50424

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50686

50767 **Structure in the energy spectra of the fragments produced in damped heavy-ion reactions.** Hilscher, D.; Birkelund, J.R.; Hoover, A.D.; Schroeder, W.U.; Wilcke, W.W.; Huizenga, J.R.; Mignerey, A.C.; Wolf, K.L.; Breuer, H.F.; Viola, V.E. (Departments of Chemistry and Physics, Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* **20**: No. 2, 556-559(Aug 1979).

Structure in the energy spectra of specific final fragments produced in symmetric heavy-ion damped collisions is shown to

correlate with statistical evaporation processes from primary fragments. The calculations are applied and described for ^{41}Ca produced by the ^{40}Ca + ^{40}Ca reaction at a bombarding energy of 400 MeV. The calculated energy spectrum has structure at the same energies as the experimental spectrum.

50768 Nucleon exchange and A/Z equilibration in interactions of 8.3-MeV/amu ^{56}Fe ions with ^{56}Fe, ^{165}Ho, and ^{209}Bi. Breuer, H.; Glagola, B.G.; Viola, V.E.; Wolf, K.L.; Mignerey, A.C.; Birkelund, J.R.; Hilscher, D.; Hoover, A.D.; Huizenga, J.R.; Schroeder, W.U.; Wilcke, W.W. (Department of Chemistry and Cyclotron Laboratory, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **43**: No. 3, 191-194(16 Jul 1979).

Yields have been measured with discrete Z and A resolution for Fe-like fragments produced in damped collisions between 8.3 MeV/amu ^{56}Fe ions and ^{56}Fe, ^{165}Ho, and ^{209}Bi targets. Both the fragment A/Z ratio and the relationship between the variances of the mass and charge distributions are found to depend upon the degree of energy damping. These observations are consistent with similar time scales for evolution of the nucleon-exchange process, A/Z equilibration, and energy dissipation.

50769 Nuclear matter distributions with pions. Johnson, M.B. (Los Alamos Scientific Lab., NM (USA)); Bethe, H.A. *Comments Nucl. Part. Phys.;* **8**: No. 3, 75-88(Oct 1978).

Recent experiments at LAMPF on the total-cross-section differences and at SIN on the angular distribution of pions scattered by ^{40}Ca and ^{48}Ca are evaluated. The substantial shift in the position of the first diffraction minimum in the angular distribution indicates that the neutrons in ^{48}Ca extend further out than in ^{40}Ca, but by about 0.1 fm less than the prediction of density-dependent Hartree-Fock theory. The total-cross-section differences lead to the same result with somewhat less experimental uncertainty.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

50770 (LA—7789-MS) **Calculation of neutron cross sections on isotopes of yttrium and zirconium.** Arthur, E.D. (Los Alamos Scientific Lab., NM (USA)). Apr 1979. Contract W-7405-ENG-36. 118p. P 06/MF A01.

Multistep Hauser-Feshbach calculations with preequilibrium corrections were made for neutron-induced reactions on yttrium and zirconium isotopes between 0.001 and 20 MeV. Recently new neutron cross-section data have been measured for unstable isotopes of these elements. These data, along with results from charged-particle simulation of neutron reactions, provide unique opportunities under which to test nuclear-model techniques and parameters in this mass region. A complete and consistent analysis of varied neutron reaction types using input parameters determined independently from additional neutron and charged-particle data. The overall agreement between calculations and a wide variety of experimental results available for these nuclei leads to increased confidence in calculated cross sections made where data are incomplete or lacking. 75 references.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 50751, 50776

50771 (JINR—E-4-11292) **Influence of the giant dipole resonance on radiative strength functions in spherical nuclei.** Soloviev, V.G.; Stoyanov, Ch.; Voronov, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1978. 30p. U 03/MF A01.

The E1-strength functions for spherical doubly even nuclei are calculated in a wide energy interval including the giant dipole resonance (GDR). A good description of the GDR widths in ^{124}Te, ^{140}Ce and ^{142}Ce is obtained. The calculated values of the radiative strength functions near the neutron binding energy Bsub(n) are in good agreement with the experimental data. The influence of GDR on the radiative strength functions and on the total photoabsorption cross sections is studied. It is shown that in single-closed-shell nuclei the E1-strength functions near Bsub(n) are slightly influenced by GDR. The values of strength functions are determined by the fragmentation of one-phonon states lying near Bsub(n). For nuclei far from the closed shells, the influence of GDR on the radiative strength functions increases. The dipole photoabsorption sigmasub(γt) cross sections as functions of the excitation energy are calculated. The existence of substructures, but not their energy location, is reliably predicted by the theory. The available experimental data confirm the existence of substructures in the energy dependence of sigmasub(γt).

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50770, 50771

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 50424

ENERGY LEVELS AND TRANSITIONS

50772 High spin states and isomers in ^{151}Dy. Lister, C.J.; Young, G.R.; Cline, D.; Srebrny, J.; Elmore, D.; Butler, P.A.; Ledoux, R.; Fridieu, R. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **20**: No. 2, 605-618(Aug 1979).

High spin states and isomers in ^{151}Dy have been studied using the ^{122}Sn(^{32}S,3n)^{151}Dy and ^{141}Pr(^{14}N,4n)^{151}Dy reactions. Levels up to J = 53/2 have been assigned, and two isomers at 4904 keV (J = 41/2, tau/sub 1/2/ = 7 +- 2 ns) and 6032 keV (J = 49/2, tau/sub 1/2/ = 10.9 +- 0.6 ns) have been identified. Gamma transitions deexciting the isomers have B (E2) values characteristic of single-particle transitions. The yrast sequence exhibits an irregular dependence on excitation energy characteristic of an independent particle model rather than a deformed rotor. In addition, above J = 25/2 it exhibits an effective moment of inertia of 138 MeV^{-1} which is 1.18 times the rigid sphere value. These data are compared to recent spherical and deformed shell model predictions and a qualitative agreement is found between experiment and calculation.

50773 Excitation of the low-energy octupole resonance in ^{90}Zr by 0.8 GeV proton inelastic scattering. DiGiacomo, N.J.; Peterson, R.J. (Nuclear Physics Laboratory, University of Colorado, Boulder, Colorado 80309). *Phys. Rev., C;* **20**: No. 2, 693-695(Aug 1979).

Analysis of 0.8 GeV proton inelastic scattering by ^{90}Zr has yielded the angular distribution of a broad peak located at 32 A/sup -1/3/ MeV with a width of approximately 2.2 MeV. The angular distribution, extending from 1.0 to 3.2 fm^{-1}, agrees well with L = 3 collective distorted-wave Born-approximation calculations. A deformation length βR of 0.80 fm is obtained. The isoscalar energy weighted sum rule fraction exhausted by an octupole excitation at 7.2 MeV in ^{90}Zr with this deformation length is 23%. The 3$^-$ state at 2.75 MeV in ^{90}Zr is found to exhaust 8% of the isoscalar energy weighted sum rule These results are in excellent agreement with recent (α,α') work which established the existence of the low-energy octupole resonance.

50774 Nuclear data sheets for A = 105. Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). *Nucl. Data Sheets;* **27**: No. 1, 1-96(May 1979).

The available nuclear structure information for all nuclei with mass number A = 105 is presented. Various decay and reaction data are evaluated and compared. Adopted data, levels, and spin and parity assignments are given.

50775 Nuclear data sheets for A = 144. Tuli, J.K. (National Nuclear Data Center Brookhaven National Laboratory Upton, New York 11973, USA). *Nucl. Data Sheets;* **27**: No. 1, 97-154(May 1979).

Experimental nuclear structure data are presented for all known nuclides with mass 144.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50773

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

50776 Dynamical polarization in pionic atoms. Dubach, J.F.; Moniz, E.J.; Nixon, G.D. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **20**: No. 2, 725-743(Aug 1979).

Dynamical nuclear polarization occurs in pionic atoms when a nuclear excitation of appropriate multipolarity is nearly degenerate with de-excitation of a pion atomic level. This phenomenon has been studied in several nuclei, one goal being to test the pion optical potential for pion atomic states normally "hidden" because of pion

absorption. We find that, in addition to Coulomb mixing of the atomic and nuclear levels, strong interaction mixing and nuclear excitations above the lowest collective quadrupole mode are important for understanding the experimental results. All cases except ^{110}Pd can then be understood. For ^{110}Pd, additional nuclear structure information is needed to determine whether or not the conventional pion optical potential will suffice again. We discuss the sensitivity of dynamical polarization measurements to the parameters of the optical potential and to various aspects of nuclear structure. In particular, we find that pionic ^{150}Sm provides a test of the interacting boson model and that the difference in neutron and proton radii predicted by Hartree-Fock calculations affects the mixing appreciably.

50777 New interpretation of the Pt-Os transition region in terms of the interacting boson approximation model. Casten, R.F. (Brookhaven National Lab., Upton, NY (USA)); Cizewski, J.A. (State Univ. of New York, Stony Brook (USA)). *Phys. Lett., B;* **79**: No. 1, 5-9(6 Nov 1978).

The introduction of progressive and systematic departures from the O(6) limit of the interacting boson approximation model accounts for the rapid variations in the empirical characteristics of the even-even Pt-Os nuclei. This provides a new interpretation of this complex transition region complementary to geometrical models.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50795

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 50772

ENERGY LEVELS AND TRANSITIONS

50778 Nuclear data sheets for A = 159. Lee, M.A.; Reich, C.W. (Idaho National Engineering Laboratory, E G G Idaho, Inc., Idaho Falls, Idaho 83401, USA). *Nucl. Data Sheets;* **27**: No. 1, 155-227(May 1979).

The experimental results available through September 1978 from the various reaction and decay studies leading to nuclides in the A = 159 mass chain have been reviewed. These data are summarized and presented, together with the adopted level schemes and properties.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50768

50779 Neutron emission in the reaction ^{165}Ho + ^{56}Fe at E/sub lab/ = 8.5 MeV/u. Hilscher, D.; Birkelund, J.R.; Hoover, A.D.; Schroeder, W.U.; Wilcke, W.W.; Huizenga, J.R.; Mignerey, A.C.; Wolf, K.L.; Breuer, H.F.; Viola, V.E. Jr. (Departments of Chemistry and Physics, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* **20**: No. 2, 576-591(Aug 1979).

Neutron emission and α-particle emission in the ^{165}Ho + ^{56}Fe reaction have been measured for the damped-collision and fusion-fission components of this reaction at a bombarding energy of 8.5 MeV/u. The c.m. neutron energy spectra for damped collisions indicate equal temperatures for the light and heavy fragments, a result consistent with the equilibration of the excitation energy during the interaction time. Pre-equilibrium neutron emission is found to contribute less than 5%. An out-of-plane neutron anisotropy $A_2 = 0.2 +- 0.1$ is found. The measured ratios of the neutron multiplicities for the light and heavy fragments suggest a rapid approach of the fragment N/Z ratios during the collision to that corresponding to minimum potential energy of the composite system.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 50780

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 50777

50780 Possible triaxial shape of even-A mercury nuclei and a phase transition between < or = $^{196}_{80}$Hg and /sup 198,200/$_{80}$Hg. Peker, L.K.; Hamilton, J.H. (Brookhaven National Laboratory, Upton, Long Island, New York 11973). *Phys. Rev., C;* **20**: No. 2, 855-858(Aug 1979).

Evidences for the existence of triaxial shapes in the ground states of even-even nuclei are considered. Most if not all previous reports that support the existence are not definite. The observed decreasing of the energies of the 2_1^+ and 4_1^+ states for /sup 198,200/ Hg compared to the lighter Hg nuclei is opposite to the expected when N increases and deformation decreases. We show that a triaxial model with a phase transition between N = 116 and 118 qualitatively can explain the regularities in B (E2) ratios and E/sub I/ for the collective levels with I/sup -/ = 2_1^+, 4_1^+, 6^+, and 2_2^+ in / sup 192-200/Hg.

NUCLEAR REACTIONS AND SCATTERING

50781 Pure-resonance model for radiative capture of fast nucleons. Dietrich, F.S.; Kerman, A.K. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev. Lett.;* **43**: No. 2, 114-117(9 Jul 1979).

A model for radiative capture is described that is based on the same assumptions as the direct-semidirect model, but in which the giant resonance is explicitly projected out of the continuum space. Calculations on ^{208}Pb(n,γ) show that the model is much less sensitive to form-factor ambiguities than the direct-semidirect model, and that reasonable fits to data are obtained.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

50782 ^{208}Pb + n resonances for E = 25—600 keV: s-, p-, and d-wave doorway states and M1 ground-state radiative strength in ^{207}Pb. Horen, D.J.; Harvey, J.A.; Hill, N.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 478-496(Aug 1979).

High resolution neutron transmission and differential scattering measurements have been performed on ^{208}Pb and the results for E = 25—600 keV are presented. Data analyses were performed utilizing multilevel R-matrix codes. Resonance parameters (i.e., E, l, J, and Γ/sub n/) were deduced for a large fraction of the 223 resonances observed. In addition to the previously known doorway in the s-wave channel, the p-wave neutron strength function exhibits significant changes near 40 and 145 keV indicative of doorway states in the p/sub 1/2/ and p/sub 3/2/ channels, respectively. These results are in good agreement with those observed in a study of the ^{207}Pb + n reaction. It is suggested that these doorway states arise from a (d/sub 5/2/, 3^-) particle-core excitation. The d-wave strength function shows indications of a doorway at about E = 425 keV. The latter represents doorway resonances in the d/sub 3/2/ and d/sub 5/2/ channels which probably arise from a recoupling of the particle-core excitation that has been used to explain the s-wave doorway. A cumulative plot of the number of s-wave resonances vs E shows considerable curvature which indicates an increase of about 12% in the level density per 100 keV of excitation. These data were analyzed in terms of a constant temperature model with a nuclear temperature of about 0.9 MeV. The model reproduced the cumulative plot of d-wave resonances reasonably well up to E $\cong$ 500 keV, but underestimated the number of p-wave resonances. This indicates a parity dependence of the level density formula for this nucleus. Many of the resonances which had previously been thought to contribute to the ground-state M1 radiative strength are in fact formed by s and d waves, and hence, decay by E1 radiation. We deduce a considerably smaller amount of M1 radiation for E/sub x/ = 6738—7340 keV in ^{207}Pb than had been reported earlier.

50783 Question of a giant M1 resonance near 8 MeV in ^{208}Pb. Horen, D.J.; Harvey, J.A. (Oak Ridge National Lab., TN (USA)); Auchampaugh, G.F. (Los Alamos Scientific Lab., NM (USA)). *Phys. Lett., B;* **79**: No. 1, 39-42(6 Nov 1978).

Most of the ground-state radiative strength from levels near 8 MeV in ^{208}Pb is shown to be of E1 and not M1 character. In particular, a resonance reported to have B(M1 spin up) = 9 μ_0^2 must have <= 2.1 μ_0^2 if present.

NUCLEAR REACTIONS AND SCATTERING

50784 Prevalence of direct-reaction mechanism in a deeply inelastic reaction, ^{197}Au(^{19}F,^{12}B). Ishihara, M.; Shimoda, T.; Froehlich, H.; Kamitsubo, H.; Nagatani, K.; Udagawa, T.; Tamura, T. (Cyclotron Institute, Texas A M University, College Station, Texas 77843). *Phys. Rev. Lett.;* **43**: No. 2, 111-113(9 Jul 1979).

Continuum cross sections and spin polarizations of ^{12}B produced in the reaction $^{197}Au(^{19}F,^{12}B)$ induced by 186-MeV ^{19}F were measured. The observed data were reproduced very well in terms of a distorted-wave Born-approximation theory, indicating that this reaction transferring as many as seven nucleons proceeds as a direct process.

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 50795

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

50785 (LBL—7701, pp 35-38) **Production of einsteinium and fermium in reactors.** Ferguson, D.E. (Oak Ridge National Lab., TN). Apr 1979.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

A historical background for the production of Es and Fm in reactors is given. The method is that of successive neutron capture. Milligram quantities of ^{253}Es and picogram quantities of ^{257}Fm are produced annually. Effective cross sections in HFIR are tabulated. The technology presently used to isolate heavy elements is briefly sketched; it involves use of a batch solvent-extraction contractor. 5 figures, 4 tables. (RWR)

RADIOACTIVE DECAY

50786 (JINR-D—7-9734, pp 33-47) **Berkeley new element program.** Chiorso, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976.

From Seminar on reactions of heavy ions with nuclei and synthesis of new elements; Dubna, USSR (23 Sep 1975).

The $^{249}Cf(^{18}O,4n)^{263}106$ reaction was investigated with the aim of obtaining the α-active isotope of the 106 element . A cold (-5O deg C) target from an Al foil with a sprayed layer of CfF_3 was used. Simultaneously with the reaction of 106 element production observed are the following α-decay reactions: $^{263}106 \rightarrow {}^{259}104$ (approximately 1s), $^{259}104 \rightarrow {}^{255}102$(3.2 s), $^{255}102 \rightarrow$ ... (3 min). The α-active elements were identified by the time correlation and the energy of α-particles. The lifetime of the new α-activity of $^{263}106$ was found to be O.9 +-0.2 s. The isotope $^{260}104$ was obtained in the ^{249}Bk (^{15}N, 4n) $^{260}104$ reaction.

50787 (LBL—7701, pp 17-26) **Nuclear properties of einsteinium and fermium.** Huizenga, J.R. (Univ. of Rochester, NY). Apr 1979.

From Symposium commemorating the 25th anniversary of the discovery of elements 99 and 100; Berkeley, CA, USA (23 Jan 1978).

Properties of Es and Fm, determined by a number of investigators, are assembled and discussed in a historical context. They include the following: surface, Coulomb, and deformation energies; production of isotopes and decay products in Mike event and in reactors; half-lives; alpha-decay energies; neutron cross sections; Nilsson diagrams; and decay schemes. 17 figures, 3 tables. (RWR)

50788 **^{233}U levels populated in the α decay of ^{237}Pu.** Ellis, Y.A.; Emery, J. F.; Toth, K.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 799-804(Aug 1979).

The 45.3-day nuclide ^{237}Pu decays primarily via electron capture. The only information available up to now concerning the nuclide's α-decay properties has been the observation of two α groups with energies of 5.65 and 5.36 MeV. In the present study, the photon spectrum of ^{237}Pu was investigated with x- and γ-ray Ge(Li) detectors. A total of 21 transitions was found to belong to ^{237}Pu decay; of these, 16 were assigned to its α-decay branch. An α-decay scheme was constructed on the bases of transition energy fits and known ^{233}U levels (including some observed only in reaction studies). The amounts of direct α-decay feedings were then calculated from intensity balances, and a total α-branching of (4.2 +- 0.4) x 10^{-3}% was deduced. α-decay hindrance factors identify the band heads of the (5/2)[752] and (7/2)[743] orbitals in ^{233}U at 298.9 and 503.5 keV, respectively. Contrastingly, the ^{233}Pa and ^{233}Np decay studies had assigned the (7/2)[743] state to the level at 298.9 keV.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 50787

MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 50658

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50786, 50787

50789 (ORNL/TM—6758) **Th(n,xγ) reaction cross section for incident neutron energies between 0.3 and 20.0 MeV.** Morgan, G.L. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 61p. P 04/MF A01.

Differential cross sections for the neutron-induced gamma-ray production from thorium were measured for incident neutron energies between 0.3 and 20.0 MeV. The Oak Ridge Electron Linear Accelerator (ORELA) was used to provide the neutrons, and a NaI spectrometer, to detect the gamma rays at 125^0. The data presented are the double differential cross section, $d^2\sigma/d\Omega dE$, for gamma-ray energies between 0.3 and 10.6 MeV for coarse intervals in incident neutron energy. The integrated yield of gamma rays of energies greater than 300 keV with higher resolution in the neutron energy is also presented. 23 figures, 21 tables.

50790 **Statistical tests for the detection of intermediate structure: Application to the structure of the ^{238}U neutron capture cross section between 5 keV and 0.1 MeV.** Perez, R.B.; de Saussure, G.; Macklin, R.L.; Halperin, J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **20**: No. 2, 528-545(Aug 1979).

Recent measurements of the ^{238}U neutron capture cross section show a considerable amount of fluctuation between 5 and 100 keV. Statistical tests performed on the measured cross section suggest that the fluctuations are not compatible with the statistical model of nuclear reactions and imply the existence of intermediate structure, which is interpreted in terms of doorway states. The validity of the statistical tests used here is confirmed by numerical experiments with simulated cross sections generated by the Monte Carlo method, in accordance with the statistical method. The behavior of the capture cross section is compared to those of the subthreshold fission cross section and of the inelastic scattering cross section. The threshold anomaly at the opening of the inelastic channel at 45 keV is seen in the form of a rounded step.

NUCLEAR THEORY

NUCLEAR STRUCTURE

50791 **Isomer shifts and nuclear models. Chapter 13.** Speth, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik); Henning, W.; Kienle, P.; Meyer, J. (Technische Univ. Muenchen, Garching (Germany, F.R.). Physik-Dept.). pp 795-832 of Moessbauer isomer shifts. Shenoy, G.K. (Argonne National Lab., IL (USA)); Wagner, F.E. (Technische Univ. Muenchen (Germany, F.R.)) (eds.). Amsterdam, Netherlands; North-Holland (1978).

From isomer shifts of low energy γ-rays, as observed in Moessbauer lines between chemically different compounds, one can deduce the fractional changes $\Delta(r^2)$ of the mean square nuclear charge radius even if they are as small as 10^{-5}. Complementary data of similar accuracy can be obtained from the energy shifts of γ-rays emitted by the nucleus of a muonic atom. The calculation of such small changes of nuclear radial matrix elements became a true challenge and a severe test for relevant nuclear structure theories. Moreover, very distinct features of nuclear phenomena became apparent from these extemely sensitive measurements. Already the first experimental data for rotational transitions of deformed nuclei by Kienle et al. [1968] suggested the marked predominance of Coriolis antipairing effects in rotating nuclei - a feature which has been recently described quantitatively in terms of a microscopic theory of nuclear rotation by Meyer and Speth [1973]. Similarly the importance of core polarization effects in single particle transitions became apparent in early studies of proton and especially neutron transitions, and have been explained theoretically.

50792 **Semiclassical methods at finite temperature.** Dolan, L.; Kiskis, J. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **20**: No. 2, 505-513(15 Jul 1979).

Semiclassical path-integral methods are applied to the quantum-mechanical double-well potential at finite temperature. When all parameters are fixed and $h \rightarrow 0$ the quantum tunneling transitions which maintain the symmetry at zero temperature are absent. Classical thermal fluctuations, however, give transitions which partially disorder the system.

NUCLEAR MATTER

50793 **Pion absorption in highly excited nuclear matter.** Ko, C. (Nuclear Science Division, Lawrence Berkeley Laboratory, Univer-

sity of California, Berkeley, California 94720). *Phys. Rev., C;* **20**: No. 2, 757-763(Aug 1979).

Motivated by pion productions in high-energy heavy-ion collisions, we study the p-wave pion absorption in highly excited nuclear matter. The basic absorption mechanism is the two-nucleon model with both pion and rho-meson rescattering. The excited nuclear matter is modeled by a finite temperature Fermi gas. We deduce that for a given pion kinetic energy, the mean free path for pion absorption depends weakly on the temperature of the nuclear matter, but strongly on the density. Its relevance to high-energy heavy-ion collisions is discussed.

50794 Variational theory of fermion matter with spin dependent correlations. Owen, J.C. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Ann. Phys. (N.Y.);* **118**: No. 2, 373-413(Apr 1979).

A variational wave function is constructed for a system of fermions interacting with a spin dependent potential. The correlations due to the repulsive core of the potential are described by a spin independent Jastrow product ansatz and the correlations due to the longer range part of the potential, which are assumed to be spin dependent, are described by an independent pair ansatz. A cluster expansion is derived for the variational energy and a set of hypernetted chain (HNC) equations obtained to sum the cluster series in terms of the elementary diagrams. Neglecting the elementary diagrams, the HNC equations are solved numerically for the spin dependent potential, V3, in neutron matter. The introduction of spin dependent correlations is found to give a small lowering of the variational energy in the HNC approximation. The results are very sensitive to an accurate treatment of the many-body terms within HNC approximation, however, and it is shown that additional approximations can easily lead to an exaggeration of the spin dependent correlations.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 50792, 50793

50795 (JINR-D—7-9734, pp 101-110) **Mechanism of heavy-ion reactions and the production of superheavy nuclei.** Nix, J.R. (Los Alamos Scientific Lab., NM (USA)); Sierk, A.J. (California Inst. of Tech., Pasadena (USA). W.K. Kellogg Radiation Lab.). 1976.

From Seminar on reactions of heavy ions with nuclei and synthesis of new elements; Dubna, USSR (23 Sep 1975).

The statics and dynamics of very-heavy-ion reactions, with special emphasis on those aspects associated with the production of superheavy nuclei, are discussed. Cross sections for forming compound nuclei in symmetric heavy-ion collisions of the ^{150}Nd + ^{150}Nd ^{300}200 types are calculated by the use of the criterion that the dynamical trajectory for the fusing system must pass inside the fission saddle point in a multidimensional space in order to form a compound nucleus.

50796 (JINR-D—7-9734, pp 89-100) **Macroscopic description of the interaction between two complex nuclei.** Swiatecki, W.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976.

From Seminar on reactions of heavy ions with nuclei and synthesis of new elements; Dubna, USSR (23 Sep 1975).

The interaction of compound nuclei is considered within the framework of the macroscopic approach, when the number of particle A in the nucleus is large ($A^{-1} < < 1$) and the discreteness of nucleons can be neglected. An important problem in such a description of nuclear interaction is taking into account the evolution of the shape or configuration of the nuclear system. In describing various types of collisions, scattering, and production of a complex nuclear system on nuclear fusion or on capture of one nucleus by another, one of the basic characteristics is the potential energy as a function of the system configuration. Charts of the potential energy for different shapes of a two-nuclei system are presented. In explaining the nuclear system dynamics the author draws as analogy between vibrations of a nucleus (or a system of nuclei) and of a viscous liquid.

50797 Effect of P-wave pion absorption on two nucleons and low-energy pion-nucleus scattering. Rockmore, R. (Rutgers - the State Univ., New Brunswick, NJ (USA). Dept. of Physics); Kanter, E. (Argonne National Lab., IL (USA). Physics Div.). pp 422-423 of Few body systems and nuclear forces. Pt. 1. Zingl, H.; Haftel, M.; Zankel, H. (eds.) (Graz Univ. (Austria). Inst. fuer Theoretische Physik). Berlin, Germany, F.R.; Springer (1978).

From Conference on few body systems and nuclear forces; Graz, Austria (24 Aug 1978).

Theoretical efforts in π-nucleus scattering have recently been directed at incorporating the effect of the pion absorption, which becomes important in the low-energy domain, into the usual optical model description. We report here the results of a calculation of the effect of P-wave pionic absorption on low-energy elastic and inelastic pion-nucleus scattering in the energy interval 60 MeV <= T <= 120 MeV.

50798 Test of bound-state approximations in a three-body model of rearrangement collisions. Greben, J.M.; Levin, F.S. (TRIUMF and University of British Columbia, Vancouver, British Columbia V6T 1W5, Canada). *Phys. Rev., C;* **20**: No. 2, 437-445(Aug 1979).

A common approximation in atomic, molecular, and nuclear rearrangement processes is to neglect n-body breakup contributions (n > or = 3) by replacing the full wave function by (sums of) product wave functions, each of which is related to a specific asymptotic arrangement channel. We test this bound-state approximation in a simple three-body model of nuclear stripping by comparing bound-state approximation calculations with exact and distorted-wave Born-approximation-type calculations. Calculated are the stripping and elastic amplitudes and cross sections for deuteron energies E/sub d/ = 1.78, 6.7, 11.2, and 15.12 MeV. The bound-state approximation is best below the breakup threshold (E/sub BU/ = 2.225 MeV), where it provides an excellent fit in the forward direction and a qualitative fit over the whole angular range. For E/sub d/ = 6.7 MeV the breakup cross section is still very small; however, the intermediate continuum states already play an important role and the bound-state approximation becomes quite poor. At this energy the distorted-wave Born approximation-type calculation, which is based on exact elastic wave functions and therefore accounts partly for the continuum, is still quite good. For the two higher energies both continuum and multistep effects appear to be very important, rendering both distorted-wave Born approximation and bound-state approximation poor approximations outside the forward region. The qualitative features of the elastic cross sections are explained in terms of the momentum dependence of the bound-state wave functions and two-body T matrices.

50799 Coulomb effects in the Klein-Gordon equation for pions. Cooper, M.D.; Jeppesen, R.H.; Johnson, M.B. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **20**: No. 2, 696-704(Aug 1979).

We find a simple analytic expression which approximates the relativistic Coulomb scattering of a spinless particle from the Coulomb field of a point source. We discuss the application of our result for various aspects of pion-nucleus scattering. The results are easily extended for spinless heavy ions.

50800 Particle production in nucleon-nucleus and nucleus-nucleus collisions: Fermi motion versus collective tube mechanisms. Vary, J.P.; Lassila, K.E.; Sandel, M.S. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., C;* **20**: No. 2, 715-724(Aug 1979).

Within the general framework of multiple scattering theory for particle production in nucleon-nucleus and nucleus-nucleus collisions we investigate the results of two limiting situations: independent multiple collisions with Fermi motion effects versus the collective tube model with the assumption of universality for the elementary cross sections. Dramatically different predictions may be obtained. We summarize the results for pion multiplicity distributions in nucleus-nucleus collisions to assess the possible evidence for a coherent-collective mechanism and find that no strong conclusion is possible with the currently available pion multiplicity data. Attention is then focused on potentially more conclusive tests: subthreshold (in the nucleon-nucleon kinematics) production of massive particles, p-bar, psi/J, and W as examples. Evidence for a collective mechanism is found by examining subthreshold p-bar production data in particle-nucleus collisions. However, owing to the limited scope of these data a firm conclusion is probably premature. Further p-bar production experiments are proposed. With the assumption that the coherent mechanism can be proved, it is worth studying the possibility of producing other massive particles, especially in nucleus-nucleus collisions where the collective effects have large subthreshold consequences. Within the (limited) framework of universality we then present predictions for the subthreshold production of psi/J and the W boson. Owing to the qualitative nature of our assumptions and since these approaches bracket the p-bar data, we expect that the collective tube model provides an optimistic limit and independent multiple collisions a pessimistic limit for W production cross sections.

5u801 Pion production in nuclear collisions with Fermi motion effects. Sandel, M.; Vary, J.P.; Garpman, S.I.A. (Ames Laboratory: United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., C;* **20**: No. 2, 744-756(Aug 1979).

The independent multiple collision model for pion production in nuclear collisions is extended to include the effects of Fermi motion. We have developed an analytic expression for the distribution of invariant mass for colliding nucleons whose momentum distributions are in relative motion. This expression is tractable if the colliding distributions are described in terms of Gaussian functions. We make use of this formalism to calculate Fermi averaged cross

sections for pion production, using as input multi-Gaussian fits to momentum distributions obtained from nuclear structure calculations. We have calculated charged pion multiplicity distributions and inclusive cross sections for proton-nucleus and nucleus-nucleus collisions. We use a phenomenological method for incorporating the effects of energy loss by participant nucleons and pion reabsorption. Sample calculations are presented and compared with available experimental data. We discuss the striking effect of Fermi motion on pion production at bombarding energies below the nucleon-nucleon pion production threshold.

NUCLEAR MODELS

50802 Variational derivation of a time-dependent Hartree-Fock Hamiltonian. Lichtner, P.C.; Griffin, J.J.; Schultheis, H.; Schultheis, R.; Volkov, A.B. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **20**: No. 2, 859-860(Aug 1979).

The variational derivation of the time-dependent Hartree-Fock equation is reviewed. When norm-violating variations are included, a unique time-dependent Hartree-Fock Hamiltonian, which differs from that customarily used in time-dependent Hartree-Fock analyses, is implied. This variationally "true" Hartree-Fock Hamiltonian has the same expectation value as the exact Hamiltonian, equal to the average energy of the system. Since this quantity remains constant under time-dependent Hartree-Fock time evolution, we suggest the label "constant <H>" for this form of time-dependent Hartree-Fock theory.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 50522

50803 (ORNL/TM—6807) **BREESE-II: auxiliary routines for implementing the albedo option in the MORSE Monte Carlo code.** Cain, V.R.; Emmett, M.B. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 37p. P 03/MF A01.

The routines in the BREESE package implement the albedo option in the MORSE Monte Carlo Code by providing (1) replacements for the default routines ALBIN and ALBDO in the MORSE Code, (2) an estimating routine ALBDOE compatible with the SAMBO package in MORSE, and (3) a separate program that writes a tape of albedo data in the proper format for ALBIN. These extensions of the package initially reported in 1974 were performed jointly by ORNL, Bechtel Power Corporation, and Science Applications, Inc. The first version of BREESE had a fixed number of outgoing polar angles and the number of outgoing azimuthal angles was a function of the value of the outgoing polar angle only. An examination of differential albedo data led to this modified version which allows the number of outgoing polar angles to be dependent upon the value of the incoming polar angle and the number of outgoing azimuthal angles to be a function of the value of both incoming and outgoing polar angles.

50804 (UCID—18229) **Chapman—Enskog approach to flux-limited diffusion theory.** Levermore, C.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jul 1979. Contract W-7405-ENG-48. 19p. P 02/MF A01.

Using the technique developed by Chapman and Enskog for deriving the Navier—Stokes equations from the Boltzmann equation, a framework is set up for deriving diffusion theories from the transport equation. The procedure is first applied to give a derivation of isotropic diffusion theory and then of a completely new theory which is naturally flux-limited. This new flux-limited diffusion theory is then compared with asymptotic diffusion theory.

50805 (UCRL—50400(Vol.17)(Pt.F)) **DOWNER (version 79-1): group collapse cross section and transfer matrices.** Cullen, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1979. Contract W-7405-ENG-48. 49p. P 03/MF A01.

FORTRAN-callable subroutines are provided to allow a user to group-collapse cross sections and/or transfer matrices from any arbitrary initial group structure to any arbitrary final group structure. 3 figures.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 49965, 49966, 50379, 50805

50806 Spectrum of the multigroup neutron transport operator for bounded spatial domains. Larsen, E.W. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Math. Phys. (N.Y.);* **20**: No. 8, 1776-1782(Aug 1979).

The spectrum of the multigroup neutron transport operator A is studied for bounded spatial regions D which consist of a finite number of material subregions. Our main results provide simple conditions on the material cross sections which guarantee that (1) A possesses eigenvalues in the finite plane; (2) A possesses a "leading" eigenvalue λ_0 which is real, not less than the real part of any other eigenvalue, and to which there corresponds at least one nonnegative eigenfunction psi/sub lambda/0; and (3) A possesses a "dominant" eigenvalue λ_0 which is real, simple, greater than the real part of any other eigenvalue, and whose eigenfunction psi/sub lambda/0 satisfies psi/sub lambda/0> or =0 and $\int$psi/sub lambda/0$d^2\Omega>0$. We give examples to illustrate the results and to show that a leading eigenvalue need not be simple, nor its eigenfunction(s) positive.

DOSIMETRY

REFER ALSO TO CITATION(S) 50481

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 50333, 50659

50807 (CONF-790442—17) **Epitaxy and misfit dislocations in large misfit systems.** Vook, R.W. (Syracuse Univ., NY (USA). Dept. of Chemical Engineering and Materials Science). 1979. Contract EG-77-S-02-4496. 26p. P 03/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (23 Apr 1979).

The manner in which an epitaxial overgrowth is accommodated to a substrate composed of a different material depends on such factors as the surface and interfacial energies and the lattice misfit. The former tends to control the growth mode while the latter is an important factor in determining the magnitude and presence of elastic strain and misfit dislocations. In small misfit systems, the overgrowth tends to be pseudomorphic with the substrate up to a critical thickness beyond which the elastic strain decreases as the misfit dislocation density increases. In large misfit systems pseudomorphism doesn't occur because the critical thickness is less than a monolayer. Also the expected misfit dislocation spacing is less than what can be resolved by conventional transmission electron microscopy. Experimental results, however, indicate fairly widely spaced dislocations with average spacings that are weakly if at all dependent on overgrowth thickness. By contrast the elastic strains decrease in the expected manner as the film thickens. The inadequacy of the conventional lattice misfit theory in large misfit systems is not surprising because in this case one of the basic assumptions of the theory is violated. Namely small areas of poor fit are not separated by large areas of good fit. In fact, essentially the whole interface consists largely of regions of poor fit. For this reason, it has been suggested that coincidence lattice misfit theory may be more usefully applied to the growing bilayer in a manner analogous to the natural lattice misfit theory used for small misfit systems. Recent experimental results on various systems using smooth (111) fcc metal substrates have lent substantial support to this view.

50808 (SAND—79-1511C) **High pressure studies of ionic conductivity in solids.** Samara, G.A. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 26p. (CONF-790709—6). P 03/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

The pressure dependence of the ionic conductivity provides information about the volume relaxation associated with the formation of lattice defects as well as with the diffusive motion of these defects, and thereby helps elucidate the conduction process. Pressure results on a variety of crystals will be discussed with emphasis on recent results on crystals with large lattice polarizabilities and soft phonon modes. Pressure is shown to be an important--sometimes essential, variable in the study of ionic transport processes.

50809 (UCRL—82595) **Photoacoustic theory made easy.** Rosencwaig, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Apr 1979. Contract W-7405-ENG-48. 6p. (CONF-790819—2). P 02/MF A01.

From Topical meeting on photoacoustic spectroscopy; Ames, IA, USA (1 Aug 1979).

Simple formulas for the photoacoustic effect are derived from basic physical insights.

50810 (UCRL—82597) **Photoacoustics: more than spectroscopy.** Rosencwaig, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Apr 1979. Contract W-7405-ENG-48. 5p. (CONF-790819—4). P 02/MF A01.

From Topical meeting on photoacoustic spectroscopy; Ames, IA, USA (1 Aug 1979).

Non-spectroscopic applications of the photoacoustic effect are reviewed and new potential [illegible] discussed

50811 (UCRL—82598) **Photoacoustic spectroscopy of condensed matter: a review.** Rosencwaig, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Apr 1979. Contract W-7405-ENG-48. 6p. (CONF-790819—3). P 02/MF A01.

From Topical meeting on photoacoustic spectroscopy; Ames, IA, USA (1 Aug 1979).

Some of the major highlights in the development of photoacoustic spectroscopy since 1973 are presented, and new trends in the field are outlined.

50812 **Monte Carlo renormalization group and Ising models with n > or = 2.** Swendsen, R.H.; Krinsky, S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **43**: No. 3, 177-180(16 Jul 1979).

We suggest that the Monte Carlo renormalization group, when combined with the type of cell-spin transformation introduced by van Leeuwen, should be a powerful tool in the study of Ising models with n > or = 2. Numerical results are presented for the Baxter model and the Ising model with nearest— and next-nearest—neighbor interactions on a square lattice.

50813 **Pseudopotential panacea.** Cohen, M.L. (University of California, Berkeley). *Phys. Today;* **32**: No. 7, 40-47(Jul 1979).

Potentials for describing the behavior of valence electrons in solids have considerably advanced our understanding of real materials, including their optical spectra, bonding, superconductivity and surfaces.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 50342

50814 (BNL—26441) **Density of states and T/sub c/ of disordered A15 compounds.** Ghosh, A.K.; Strongin, M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 12p. (CONF-790653—10). P 02/MF A01.

From Superconductivity in d- and f-band metals; San Diego, CA, USA (21 Jun 1979).

In this paper various data for the depression of T/sub c/ and N(O) are presented for a wide class of A15 materials. The question of disorder and the limits on T/sub c/ in these materials are discussed.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 50820

50815 (EPRI-NP—1089) **GLASS II: global—local finite element analysis of structural systems.** Bradford, L.G.; Dong, S.B.; Tessler, A.; Westmann, R.A. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Jun 1979. 283p. P 13/MF A01.

A computer program with acronym GLASS-II is described. This code is based on the concept of global—local finite elements, wherein both contemporary finite element and classical Rayleigh—Ritz approximations are simultaneously employed. The library of elements in GLASS-II include the axisymmetric element, planar element, three-dimensional solid element, plate bending element, and shell element. Moreover, for the axisymmetric and planar elements, general loading conditions can be treated by their expansion in terms of Fourier series. Derivation of the element matrices and consistent load vectors are described in detail. A brief description of the GLASS-II computer code is given, which at the present time is checked out for static analysis problems. A version with dynamic analysis capabilties is forthcoming. Instructions concerned with the programming of the global functions (a term used to denote the Rayleigh—Ritz approximations) are provided. These functions depend on the problem to be analyzed and must be provided by the user/analyst. The user's manual is contained in Appendix I and the computer listing of the GLASS-II code appears as Appendix I and the computer listing of the GLASS-II code appears as Appendix II. This code has been applied to the calculation of stress intensity factors and to problems involving a half-space. These applications evince the modeling versatility and computational effectiveness inherent in global—local finite element analysis. 10 figures.

50816 **Model three-body problem in the molecular mass limit.** Fonseca, A.C.; Shanley, P.E. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Ann. Phys. (N.Y.);* **117**: No. 2, 268-291(Feb 1979).

The bound states of a three-body molecule composed of two identical heavy nuclei and a light "electron" interacting through short-range s-wave potentials are studied. The spectrum of three-body bound states grows as the mass ratio m between the heavy and light particles increases, and presents a remarkable vibration rotation structure that can be fitted with the usual empirical energy formulas of molecular spectroscopy. The results of the exact three-body calculation for the binding energy and bound-state wavefunction are compared with the predictions of the Born-Oppenheimer method for the same system. We find that for m>30, the Born-Oppenheimer approximation yields very good results for both the binding energies and wavefunctions. For smaller m (1<m<30) the Born-Oppenheimer results are still surprisingly good and this is shown to be related to the range of the two-body interactions.

RELATIVITY AND GRAVITATION

50817 **Equivalence of two approaches to noninertial observers.** DeFacio, B.; Dennis, P.W.; Retzloff, D.G. (Department of Physics, University of Missouri-Columbia, Columbia, Missouri 65211). *Phys. Rev., D;* **20**: No. 2, 570-571(15 Jul 1979).

An equivalence relation between our exact formula for special-relativity noninertial acceleration and the special-relativity part of a general-relativity approximate expression by Ni and Zimmerman is given.

OPTICS

50818 **Thermal emissivity of selective surfaces: New lower limits.** Trotter, D.M. Jr.; Sievers, A.J. (Laboratory of Atomic Solid State Physics, and Materials Science Center, Cornell University, Ithaca, New York 14853). *Appl. Phys. Lett.;* **35**: No. 5, 374-376(1 Sep 1979).

Numerical calculations of the thermal emissivity ϵ of spectrally selective surfaces consisting of absorbing films on reflective metal substrates are reported. A physically realizable form for the absorption coefficient of the film $\alpha(\omega)$, and a refractive index $n(\omega)$ derived from $\alpha(\omega)$ via a Kramers-Kronig relation were used to obtain new lower limits for ϵ.

50819 **Polarization-rotation and thermal-motion studies via resonant degenerate four-wave mixing.** Steel, D.G.; Lind, R.C.; Lam, J.F.; Giuliano, C.R. (Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, California 90265). *Appl. Phys. Lett.;* **35**: No. 5, 376-379(1 Sep 1979).

We report experimental observation of polarization rotation in resonant degenerate four-wave mixing (DFWM) arising from the third-order coupling of the electric fields. This effect allows investigation of molecular motion and its effect on the efficiency of the DFWM. By controlling the pulse width and therefore $\gamma = T_0/\tau$ (where T_0 equivalent λ/v sub th) we show quantitative agreement with a third-order density matrix perturbation calculation. In particular, using a CO_2 laser at 10.6 μm and SF_6 as the nonlinear medium, we show that for $\gamma >> 1$ (stationary limit) we see no molecular motion and for $\gamma \simeq 1$, we see a significant "washout" of one third—order polarization.

50820 **Structure and representation of correlation functions and the density matrix for a statistical wave field in optics.** Sudarshan, E.C.G.; Mukunda, N. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *J. Math. Phys. (N.Y.);* **20**: No. 8, 1801-1810(Aug 1979).

A systematic structure analysis of the correlation functions of statistical quantum optics is carried out. From a suitably defined auxiliary two-point function we are able to identify the excited modes in the wave field. The relative simplicity of the higher order correlation functions emerges as a byproduct and the conditions under which these are made pure are derived. These results depend in a crucial manner on the notion of coherence indices and of unimodular coherence indices. A new class of approximate expressions for the density operator of a statistical wave field is worked out based on discrete characteristic sets. These are even more economical than the diagonal coherent state representations. An appreciation of the subtleties of quantum theory obtains. Certain implications for the physics of light beams are cited.

50821 **Theory of temporal pump stochasticity in stimulated Raman scattering in dispersionless media.** Eimerl, D. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Math. Phys. (N.Y.);* **20**: No. 8, 1811-1823(Aug 1979).

A diagrammatic formalism is presented which gives exact results for the forward Stokes wave in dispersionless media in the field of a temporally stochastic pump. Both pump and Stokes waves are assumed to be plane waves, but transient effects are treated exactly. Results are derived in the Bourret approximation for the n-point functions (n>2) but are exact to all orders in the mean pump field and its two-point function. The generalization to treat general n-point functions within this formalism is possible and the method of doing so is indicated. The partial summation of diagrams corresponding to previous treatments is identified and the next orde

terms are evaluated. It is found that for high gain systems, approximations made in previous work may be quite poor.

50822 Bounds on stimulated Raman scattering. Eimerl, D. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., A;* **20**: No. 1, 369-371(Jul 1979).

It is proved that the quantum theory of stimulated light scattering predicts that the gain is bounded by the classical steady-state gain under monochromatic pumping.

50823 Rate equations in stimulated light scattering. Kelley, P.L. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Phys. Rev., A;* **20**: No. 1, 372-375(Jul 1979).

A set of rate equations which gives results not previously obtained has been proposed for stimulated light scattering. These equations are shown to be invalid under the conditions where the novel results appear.

50824 Macroscopic quantum fluctuations in superfluorescence. Haake, F.; King, H.; Schroeder, G.; Haus, J.; Glauber, R.; Hopf, F. (Fachbereich Physik, Gesamthochschule Essen, 43 Essen, West Germany). *Phys. Rev. Lett.;* **42**: No. 26, 1740-1743(25 Jun 1979).

We show that superfluorescent pulses fluctuate significantly in shape notwithstanding their classical dynamical behavior. These fluctuations can be understood as originating from the quantum mechanical uncertainty of the initial polarization.

ELECTRICITY AND MAGNETISM

50825 Domain-wall energies in thin magnetic films. Middleton, B.K. (Department of Electrical and Electronic Engineering, Manchester Polytechnic, Chester Street, Manchester M1 5GD, England). *J. Appl. Phys.;* **50**: No. 8, 5552-5553(Aug 1979).

Recent estimates of domain-wall energies, obtained from domain-tip-motion threshold fields in thin magnetic films, have been analyzed. It is revealed that either the theoretical understanding of domain-tip motion is inadequate or that measurements of anisotropy in thin films do not reflect the true effective anisotropy experienced by domain walls.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 50741, 50812

50826 Evaluation of SU(6) ⊂ SU(3) xSU(2) Wigner coefficients). Strottmanb), D. (Department of Physics, State University of New York, Stony Brook, New York 11794). *J. Math. Phys. (N.Y.);* **20**: No. 8, 1643-1647(Aug 1979).

A technique is described which allows the calculation of any SU(6) Wigner coefficient (isoscalar factor) from known one-body SU(6) coefficients. The technique is applied to calculate the SU(6) coefficients for $q^3 \times q^3$ leading to SU(3) singlet, octet, and decuplet states of six quarks. A sum rule of SU(3) 9-$\lambda\mu$ symbols is given.

COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY

50827 Beauty and the quest for beauty in science. Chandrasekhar, S. (University of Chicago). *Phys. Today;* **32**: No. 7, 25-30(Jul 1979).

Science, like the arts, admits aesthetic criteria; we seek theories that display "a proper conformity of the parts to one another and to the whole" while still showing "some strangeness in their proportion."

FUSION ENERGY

50828 Illumination and energy deposition in a multibeam laser-fusion system. Scannapieco, A.J.; Brysk, H. (Laser Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *J. Appl. Phys.;* **50**: No. 8, 5142-5149(Aug 1979).

Calculations are presented for multibeam laser-fusion systems illuminating spherical targets. Both the illumination pattern and the energy deposition on the surface of the target are obtained, with the beam focus in general displaced from the center of the target. The absorptivity (which depends on angle of incidence and polarization) is discussed from experimental and theoretical evidence. Numerical results are displayed for two LASL laser systems. They illustrate the distinction between the symmetry of the illumination and of the energy deposition. They also demonstrate, as a function of the relative size of the target and of the (finite) focal spot, that the absorption can be enhanced by displacing the beam axis from the center of the target.

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

50829 (IAE—2835) Effect of neutral atom beam injection on plasma diffusion in the plateau and Pfirsh-Schlutter regimes. Fomenko, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 12p. (In Russian). U 02/MF A01.

The effect of neutral particle injection on mass and heat transfers in the Tokamak plasma is considered on the basis of the kinetic equation for plasma electrons. Expressions for particle and heat flux variations due to the beam presence for the plateau and Pfirsch-Schluter modes have been obtained by means of the stationary beam distribution function. It has been found that the effect of the beam on heat transfer from plasma by ions constitutes about msub(e)/msub(i))sup(1/2)-th part of heat transfer due to the ion thermal conductivity.

50830 (JAERI-M—7551) Fast ion spatial distribution in neutral beam injection into a tokamak. Ohtsuka, M.; Tani, K.; Kishimoto, H.; Shimada, R.; Yoshida, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 20p. (In Japanese). U 03/MF A01.

Radial distribution of fast ions in neutral beam injection into a Tokamak is calculated. Injected neutral particles are ionized by plasma ions and electrons and confined in the Tokamak magnetic field. The purpose is to obtain a computer code in which there is no density divergence due to the pencil beam approximation and which can be connected with a one-dimensional Tokamak simulation code. It is assumed that fast ions move on the magnetic surfaces and are distributed uniformly in toroidal and poloidal directions. Equations are derived for the neutral beam of finite cross section injected with an arbitrary injection angle. Numerical calculation for JT-60 shows that the density divergence does not take place in the code. Comparison of this calculation and that by pencil beam approximation shows that the latter gives good approximate values for JT-60 if the approximation is a little modified.

50831 (KFTI—77-33) Rotation and transfer of plasma filament particles under the effect of external forces and currents. Nemov, V.V. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1977. 21p. (In Russian). U 03/MF A01.

Rotation of plasma filament under the effect of external forces has been theoretically studied. These forces, for instance, can appear under the plasma heating by electromagnetic waves or by neutral particle beam injection. The data obtained make it possible to conclude on the possibility to avoid the dangerous velocity of the plasma filament rotation under the high-frequency plasma heating or the neutral particle beam heating. To achieve this it is necessary, first, that the intensity of heating was large enough, so that the growth rate of plasma temperature was of the order of the energy transfer rate from the wave or beam into the plasma, second that the wave phase rate in the direction perpendicular to the magnetic field or velocities of neutral particle beam were greater than the ion velocity. In this case the rotation velocity of the plasma filament achieved during the heating, appears to be less than the ion thermal velocity.

50832 (KIYI—77-18) α-particle containment in noncircular section tokamaks. Kolesnichenko, Ya.I.; Yavorskii, V.A. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1977. 17p. (In Russian). U 02/MF A01.

The containment problem of fast ions formed in a thermonuclear reaction of resulting from neutral injection is studied in noncircular section tokamaks. A method is developed for determination of number and space distribution of fast ions impinging the chamber walls of an axisymmetric tokamak with an arbitrary section form. Formulas giving the α-particle containment coefficient and their flux density to the chamber walls are obtained for elliptical section tokamaks. The comparative analysis of α-particle containment in tokamak with elliptical and circular sections is carried out.

50833 (RISO—385) Alfa-particle heating of a thermonuclear plasma. Kofoed-Hansen, O. (Risoe National Lab., Roskilde (Denmark)). Sep 1978. 45p. U 03/MF A01.

The theory of the slowing down and thermalization of alfa-particles created in and slowed down by a plasma considered as an undisturbed thermal bath is re-examined. The considerations are limited to a homogeneous, isotropic plasma. Also the alfa-particles are considered as a density-wise negligible component of the plasma. Under these circumstances, all essential parts of the theory can be studied analytically. Thus all standard approximations can be studied with precision. However, the conclusions do not differ from numeri-

cal results earlier obtained by numerous authors. In this sense the present paper must be considered as a review based on analytical methods. The standard approximations referred to are such as the neglect of the variation of the Coulomb logarithm with velocity, the influence of quantum-mechanical effects, the significance of the impact parameter cut-off (the Debye length), and the assumption of a Maxwellian plasma. Some of these effects have been examined analytically by other authors. However, the present work shows that the Fokker-Planck equation can be solved without the aid of computers for the simplest set of standard approximations. The result thereof is a determination of slowing down rates and rate of growth of energy spread and thereby thermalization of the alfa-particles.

50834 Vacuum photodiode detector array for broadband UV detection in a tokamak plasma. Zweben, S.J.; Menyuk, C.R.; Taylor, R.J. (Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles, California 90024). *Rev. Sci. Instrum.;* **50**: No. 8, 972-978(Aug 1979).

An array of vacuum photodiode detectors has been used to monitor discharge equilibrium, stability, and cleanliness in the Macrotor tokamak. These detectors use the photoelectric effect on small tungsten plates to measure UV emission in the band $\lambda \sim 200$—1200 A, and so are sensitive mainly to impurity line radiation in Macrotor. The response of this system to controlled impurity contamination experiments and to disruptions is described. The design, construction, and background problems associated with these detectors are discussed in detail.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 50834

50835 (CLM-R—179) **DITE tokamak multi-pulse Thomson scattering system.** Prentice, R. (UKAEA, Abingdon. Culham Lab.). May 1978. 52p. U 04/MF A01; Also available from H.M. Stationery Office, price Pound1.50.

A four pulse ruby laser scattering system for measuring electron temperature and density in a tokamak plasma is discussed in detail. It is shown that the divergence of the laser has to be adequately controlled. By using notch filters to eliminate the stray laser light, instead of baffles, measurements can be performed at any position over a large fraction of the minor diameter of the plasma. The transmission of the detecting system was optimised using a computer ray tracing programme. Results from the apparatus are shown to be in substantial agreement with those obtained using other techniques.

50836 (EUR-CEA-FC—913) **Vacuum ultra-violet spectroscopy on T.F.R. Tokamak plasmas.** (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Sep 1977. 33p. U 03/MF A01.

Spectroscopic measurements in the range 5 to 2000 A on T.F.R. are presented. This machine is a source of large volume, high temperature (kTsub(e) approximately 2keV) and relatively low density (nsub(e) approximately $8.10^{13}cm^{-3}$). The working gas (H_2 or D_2) is contaminated by light (O, C, N) or heavy (Mo, Fe) impurities, the former being fully ionized in the central region of the plasma, the latter existing as highly charged ions with some remaining bound electrons (Mo^{30+}). Unknown spectra of molybdenum ions are studied in details in the range 5 - 100 A; spatio-temporal behavior of the various impurity ions are studied between 100 and 2000 A. Radiances (Watts $cm^{-2}sr^{-1}$) are interpreted in terms of ion densities through models which are all based on the coronal approximation either at equilibrium (central part of the plasma during current plateau) or in the transient regime (beginning of the discharge and peripheral zone of the plasma). Total radiation losses are deduced. In the range 1200-2000 A, ion temperature is deduced from Doppler measurements of some light impurity lines.

50837 (IAE—2836) **Measuring amplitude-angular distributions of the langmuir noises appearing in a plasma during oncoming magnetic field annihilation.** Zhuzhunashvili, A.I.; Oks, E.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 28p. (In Russian). U 03/MF A01.

An optical method for measuring amplitude-angular distributions of the HF Langmuir turbulence is described, based on polarization analysis of the Stark profiles of hydrogen spectral lines. The Langmuir turbulence level has been for the first time determined by this method. It is shown besides that annihilation of opposite magnetic fields on the surface corresponding to zero field intensity is liable to generate a plasma layer with a maximum density. It has been found that not only LF instabilities but also the Langmuir noise are developed in this layer. Analysis of the experimental data shows that: 1) the effects associated with plasma inhomogeneity did not have tangible effect on the spectral line profiles detected; 2) the Langmuir noise fields are oriented in the "current-magnetic field"plane tangential to the plasma layer; therefore it may be speculated that in a plasma layer of delta thickness the fundamental Langmuir mode is developed characterized ,in particular, by the wave vector radial he fundamental Langmuir mode is developed characterized ,in particular.

50838 (IAE—2906) **Study on plasma visible radiation spatial distribution at the TO-1 tokamak.** Molotkov, L.I.; Shvindt, N.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 12p. (In Russian). U 02/MF A01.

The results of spatial distribution measurements of radiation intensities of spectral lines of hydrogen and light plasma impurities in the visible-light spectrum TO-1 tokamak are described. The method of electrochemical scanning with the help of rotating disk with notches was used. The experiments were carried out in the stable regime of discharge and in the regime with breakdown instability. In the stable regime absolute intensities of the spectral lines were measured. The concentration of radiating atoms and ions were calculated using the measured absolute intensities. Besides in order to determine the region in which the discharge appears in the cross section of the TO-1 chamber the spatial distributions of Hsub(β) neutral hydrogen spectral line in the initial stage of the discharge ($0<t<1$ mc) were obtained. In the unstable regime of the discharge the effect of instability on the time dependence of the spectral line intensities and on their spatial distributions was studied. The described spectroscopic method permitted to obtain the filament cross section distribution of C(3) carbide ion and neutral hydrogen atom concentrations in the stable discharge regime. The distributions obtained have the form of the graphs with a dip in the central part and a maximum close to the plasma periphere. The average filament cross section concentration values are the following: anti nsub(C(3))$=8.2x10^9\,cm^{-3}$ for the C(3) ion and anti nsub(0)$=1.1x10^{10}$ cm^{-3} for hydrogen atoms. The investigation into spatial distributions of the Hsub(β) line radiation in the initial stage of the filament formation showed that in the overwhelming majority of cases the discharge appears near the internal wall of the tokamak chamber.

50839 (KFTI—77-39, pp 52-60) **Peculiarities of beam shaping from a dense moving plasma for ion component spectra analysis.** Zavada, P.I.; Kalmykov, A.A.; Tereshin, V.I.; Chebotarev, V.V.; Yakubovskii, V.G.; Maslov, A.V. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

A method of ion beam extraction from plasma flows for a consequent qualitative analysis of ion energy and mass spectra are studied. The experiments were performed on the "Injector" installation, where plasma was produced by a coaxial accelerator with preliminary gas ionization by an eddy electric field and was transported in a space-periodic sign-variable magnetic field. The system of selection and reduction of plasma density, which contains drift tubes with changeable diaphragms as well as the use of diagnostic methods are described in detail. The possibility of controlled reduction of plasma flow density by 10^5 - 10^6 times on the flight distance about 50 cm was shown. Two methods of ion beam extraction from flow of plasma of reduced density are considered: without use of additional electric fields and using preliminary preacceleration. With the application of the first method a good correspondence of plasma parameters determined from measured ion energy spectra and independently by other methods is obtained. Preliminarily controlled reduction of plasma density and consequent quantitative measurements of the ion distribution function according to masses and energies provide an additional information about the moving plasma in a wide range of its parameters: up to $10^{15}\,cm^{-3}$ in density and tens of eV in ion energies.

50840 (TRITA-EPP—78-02) **'Horizontal' thermal equilibrium due to excitation transfer between excited states of neutral He in transient plasma.** Brenning, N. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Jan 1978. 11p. U 02/MF A01.

The populations of the levels and the intensities of the spectral lines emitted by neutral helium in a plasma is influenced by excitation transfer between excited levels through collisions with electrons even at very low electron densities. These processes are studied theoretically and experimentally with the following conclusions: (a) Excitation transfer is important for intensities of spectral lines emitted from plasma where the electron density exceeds a few times $10^{16}\,m^{-3}$. (b) With increasing electron density, the relative populations of levels with the same main and spin quantum number approach that determined by their statistical weight. This could be regarded as a "horizontal" thermal equilibrium, developed when the helium levels are very far from thermal equilibrium in other respects.

50841 Neutron diagnostics for pulsed high-density thermonuclear plasmas. Ekdahl, C.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Rev. Sci. Instrum.;* **50**: No. 8, 941-948(Aug 1979).

Time-resolved measurements of the neutron flux from the Scylla IV—P linear theta-pinch experiment have been made with

scintillator-photomultiplier combinations. Calibration of the detectors is accomplished by a comparison of their time-integrated output with the total neutron yield measured using a foil-activation technique for which an accurate calibration has been established. The temperature of the Maxwellian ion velocity distribution that would produce the observed flux is obtained from the Maxwellian reactivity $<\sigma v>$/sub D/D for D (d,n)He^3 and measurements of the temporal evolution of the plasma column density and dimensions. This determination of the time history of the ion temperature is in good agreement with the plasma energy measured using other techniques.

50842 **Fast-scanning heterodyne receiver for measurement of the electron cyclotron emission from high-temperature plasmas.** Efthimion, P.C.; Arunasalam, V.; Bitzer, R.; Campbell, L.; Hosea, J.C. (Princeton University Plasma Physics Laboratory, Princeton,). *Rev. Sci. Instrum.;* **50**: No. 8, 949-951(Aug 1979).

We have developed a fast-scanning heterodyne receiver into a plasma diagnostic that measures the fundamental cyclotron emission from the PLT plasma and thus ascertains the time evolution of the electron temperature profile. The receiver scans 60—90 GHz every 10 ms and is interfaced to a computer for completely automated calibrated temperature measurements.

50843 **Dielectronic satellite spectrum of heliumlike iron (Fe XXV).** Bitter, M.; Hill, K.W.; Sauthoff, N.R.; Efthimion, P.C.; Meservey, E.; Roney, W.; von Goeler, S.; Horton, R.; Goldman, M.; Stodiek, W. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Rev. Lett.;* **43**: No. 2, 129-132(9 Jul 1979).

Dielectronic satellite spectra of Fe XXV near 1.8500 A have been observed from PLT (Princeton Large Torus) tokamak plasma discharges for electron temperatures in the range from 1.5 to 3 keV and an electron density of 2×10^{13} cm^{-3}. The electron temperature was independently determined from the electron cyclotron radiation emitted by the plasma. The quality of the spectra allows a detailed comparison with theoretical predictions, which is of importance in view of diagnostic applications.

PLASMA KINETICS - GENERAL

50844 (CONF-790494—(Draft)) **Arcing phenomena in fusion devices workshop.** Clausing, R.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 125p. P 06/MF A01.

From Arcing phenomena in fusion devices workshop; Knoxville, TN, USA (5 Apr 1979).

The workshop on arcing phenomena in fusion devices was organized (1) to review the pesent status of our understanding of arcing as it relates to confinement devices, (2) to determine what informaion is needed to suppress arcing and (3) to define both laboratory and in-situ experiments which can ultimately lead to reduction of impurities in the plasma caused by arcing. The workshop was attended by experts in the area of vacuum arc electrode phenomena and ion source technology, materials scientists, and both theoreticians and experimentalists engaged in assessing the importance of unipolar arcing in today's tokamaks. Abstracts for papers presented at the workshop are included.

50845 (INDC(SEC)—70/GA) **Minutes of the fourth meeting of the joint IFRC/INDC subcommittee on atomic and molecular data for fusion. Vienna, 30 September 1978.** Lorenz, A.; Seamon, R.E. (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Oct 1978. 20p. (CONF-7809152—1). U 03/MF A01.

From 4. meeting of the joint IFRC/INDC subcommittee on atomic and molecular data for fusion; Vienna, Austria (30 Sep 1978).

This paper reports on the Fourth Meeting of the Joint IFRC/INDC Subcommittee on Atomic and Molecular Data for Fusion held in Vienna, 30 September 1978. Main topics are: a) The progress of the Atomic and Molecular Data Unit of IAEA. (Bulletin on A+M data, Atomic data Collision Index). b) The proposals for the future IAEA program on atomic and molecular data for fusion.

50846 (KFTI—77-39) **Plasma physics and the controlled thermonuclear fusion problems.** (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1977. 21p. (In Russian). U 04/MF A01.

Separate abstracts for each paper have been entered into the data base. (MOW)

50847 (KFTI—77-39, pp 19-24) **Feasibility studies and optimization of powei electrodynamic plasma guns.** Vasil'ev, V.I.; Zhitlukhin, A.M.; Solov'eva, V.G.; Skvortsov, Yu.V.; Umrikhin, N.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

A method of coordination of accelerator parameters with the energy accumulator is described. The results of the calculation of plasma movement in the interelectrode gap are given. In the calculation the model of current jumper with the consideration of real distribution of neutral gas denstiy, losses on jonization, heatings, emission, etc. was used. The results of the calculations are compared with the experiment. The parameters of the plasma produced are given.

50848 (TRITA-PFU—78-05) **Thermonuclear power and radiation losses in an intrap reactor system.** Elevant, T.; Hellblom, G. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Apr 1978. 25p. U 03/MF A01.

Total thermonuclear power and bremsstrahlung losses are determined for a reactor system based on the "Intrap" configuration under flute stable conditions and a simple density-temperature relation. Also the influence from a boundary layer with variable thickness is studied. Some numerical examples are given as illustration of the obtained results.

50849 (TRITA-PFU—78-06) **Balance of a linear plasma column confined in a transverse magnetic field.** Lehnert, B. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Aug 1978. 37p. U 03/MF A01.

The equilibrium features are investigated of a straight plasma column being confined in a purely transverse magnetic field, part of which is being generated by external conductors. Provided that stability can be secured at high beta values, the reduced transport of particles and heat in the axial direction should allow for large axial temperature gradients. It is then expected that temperatures even leading to ignition can be achieved in a pure plasma, at technically realistic column lengths.

50850 (UCRL—82296) **Prospects for generating 1-10 TPa pressures with a railgun.** Hawke, R.S.; Scudder, J.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Jul 1979. Contract W-7405-ENG-48. 6p. (CONF-790709—4). P 02/MF A01.

From VII international AIRAPT conference; La Creusot, France (30 Jul 1979).

It has been demonstrated that a plasma arc can be accelerated along two current carrying parallel rails and used to accelerate a projectile. We have performed an extensive analysis and found the task of using a railgun to accelerate an impactor plate to velocities of 10 to 40 km/s to be feasible with contemporary technology. This range of impact velocities would enable shock pressures of 1 to 10 TPa to be generated for EOS research.

PLASMA KINETICS - EXPERIMENTAL

REFER ALSO TO CITATION(S) 50841

50851 (KFTI—77-39, pp 25-31) **Turbulent processes in a pulse coaxial plasma gun.** Kalmykov, A.A.; Kutsyn, A.A.; Maznichenko, M.E.; Nikol'skii, I.K.; Pavlichenko, O.S.; Shevchuk, B.A. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

A detailed study of the main processes, accompaning the rapid acceleration regime in a pulse plasma accelerator is made. An important role of turbulent processes developing at the acceleration and determining the ion acceleration is shown. The studies were conducted at a pulse plasma accelerator in the fast particle generation regime. The determination of plasma density and the distribution of magnetic field intensity in the accelerator channel permitted to calculate values of current velocities, i.e. relative velocities of electrons and ions at different discharge stages. The measurements of the continuous spectrum emitted by the plasma, in the visible range of wave lengths showed that for a wide range of conditions during the operation with hydrogen, helium and mixture of the gasses the elctron temperature differs within the range from 0.5 to 1.5 eV for different discharge stages. For measuring the intensity of electric fields in plasma the measurements of satellites of forbidden helium lines were performed. The characteristics profiles of the permitted helium line lambda 4471 A and satellites near the forbidden line for different moments of time, obtained near the outlet from the accelerator are given.

50852 (KFTI—77-39, pp 42-51) **Study of high-energy plasma jet formation by means of a complex plasma injector system.** Kalmykov, A.A.; Tereshin, V.I.; Chebotarev, V.V.; Yakubovskii, V.G. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

The problems of high-energy plasma jet formation with low (less than 1%) content of additions at a pulse coaxial accelerator are studied. A possibility of controlling divergence of such jets space free from outer fields is considered. The shaping complex in a system of a space-periodic sign-variable magnetic field in which the spatial time-of-flight separation of the high-energy part from the slow region of the plasma jet enriched by additions takes place. At the exit from the leading field the slow region of the jet is cut-off in the field

of a pulse magnetic barrier. The control over divergence of the high-energy plasma jet is exercised in the magnetic field of a short coil in the case of full displacement of the magnetic field from plasma volume.

50853 Toroidal plasma rotation in the Princeton Large Torus induced by neutral-beam injection. Suckewer, S.; Eubank, H.P.; Goldston, R.J.; Hinnov, E.; Sauthoff, N.R. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Rev. Lett.;* **43**: No. 3, 207-210(16 Jul 1979).

Toroidal plasma rotation, generated by toroidally unbalanced neutral-beam injection into the Princeton Large Torus, has been measured by Doppler shifts of several atomic spectral lines. These measurements produce the time evolution and spatial distribution of the rotation from which a momentum confinement time, comparable to the ion energy confinement time, is deduced.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 50881

50854 (COO—2387-101) **Convective cells and their relationship to vortex diffusion in the Wisconsin Levitated Octupole.** Ehrhardt, A.B. (Wisconsin Univ., Madison (USA)). 1978. Contract EY-76-S-02-2387. 208p. P 10/MF A01.

Thesis.

The purpose of this thesis is two-fold: first, to present floating potential structure for different plasmas and operating parameters in the Wisconsin Levitated Octupole. Second, to show how the observed potential structure can be used, within the framework of vortex diffusion, to account for enhanced diffusion in the appropriate parameter regimes.

50855 (COO—2456-60) **Thermonuclear burn in wall-confined plasmas.** Kmetyk, L.N. (Columbia Univ., New York (USA). School of Engineering and Applied Science). 1979. Contract EY-76-S-02-2456. 151p. P 08/MF A01.

The one-dimensional initial value problem describing a hot, dense, thermonuclear reacting plasma which is magnetically insulated and contained between cold metal walls has been studied by means of computational simulation. The resulting time evolution of the plasma temperature, number density and magnetic field profiles includes the effects of thermal conduction and radiation energy losses from the plasma, convection, and a detailed treatment of alpha particle heating, as well as ohmic heating and magnetic field diffusion. The results are used to evaluate the net energy gains possible in a shock-heated, magnetically insulated, wall-confined fusion cycle.

50856 (IC—77-48) **Generalized Rosenbluth potentials.** Hassan, M.H.A. (International Centre for Theoretical Physics, Trieste (Italy)). May 1977. 14p. U 02/MF A01.

It is shown that the coefficients of friction and diffusion of the Balescu-Lenard equation can be derived from two "generalized Rosenbluth potentials", which reduce to the standard Rosenbluth potentials if wave effects are neglected. The potentials are evaluated explicitly in the case of Maxwellian field particles. The dominant contribution of wave effects to the potentials is due to the interaction of electron field particles with ion sound waves.

50857 (INIS-mf—4789, pp 67A-69A) **Discrete ordinates solution of the Fokker Planck equation for charged particles transport in plasma.** Shvarts, D. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). 1978.

From Joint annual meeting of the Israel Nuclear Societies Ben Gurion University of the Negev; Beersheba, Israel (28 Dec 1978).

50858 (KFTI—77-39, pp 11-18) **Study on pulsed coaxial plasma accelerator operation in the MHD approximation.** Belikov, A.G.; Goncharenko, V.P.; Goncharenko, D.K.; Derepovskij, N.I.; Nikol'skij, I.K. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

A nonstationary two-dimentional magnetohydrodynamic model of a pulse coaxial accelerator with a non-uniform distribution of operating gas along electrodes is studied. Dynamics of plasma acceleration in the channel and the influence of plasma pressure, conductivity and the Hall effect on the distribution of the discharge current in the channel is studied. The existence of two regimes of accelerator operation with formation of a current layer and with distributed current is shown. The conditions of regimes existence are formulated as limitation on target parameters. In the regime of current layer formation a density layer is formed as well. It is shown that an essential influence upon the acceleration process is produced by plasma jets occurring because of plasma density gradient. The results of quantitative calculations were compared with experimentally measured distributions of discharge current constituents and plasma density distribution. A good qualitative agreement is obtained. Besides, a good correspondence is observed in the behaviour of experimentally measured and calculated lines of the current of equal value.

50859 (KIYI—77-19) **Stable non-selfsustaining thermonuclear reaction in Tokamak-reactor.** Kolesnichenko, Ya.I.; Reznik, S.N. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1977. 12p. (In Russian). U 02/MF A01.

Possibility of a stable and energetically favourable induced thermonuclear burning in tokamaks at plasma temperature T approximately 10-20 keV is shown. The investigation is carried out considering the nonideality of α-particle confinement in plasma column. For description of transport processes in plasma neoclassical and am empirical formulas are used.

50860 (Rijnhuizen—78-110) **Neutral density in a hydrogen arc.** Goedheer, W.J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Sep 1978. 45p. U 04/MF A01.

A method to calculate the neutral density in a hydrogen plasma by means of a reduced set of rate equations is presented. The plasma is assumed to be optically thin, so that the only radiative transitions are spontaneous de-excitation and radiative recombination. In the collisional transitions only interaction with electrons is taken into account. After a description of the method it is applied to a hydrogen arc. The influence of deviations from local thermodynamic equilibrium on the temperature and pressure profiles of an infinitely long cylindrically symmetric hydrogen arc with an externally applied axial magnetic field is studied.

50861 (RISO—384) **Calculation of the ion velocity distribution function in a rotating plasma.** Joergensen, L.W. (Risoe National Lab., Roskilde (Denmark)). Oct 1978. 26p. U 03/MF A01.

Using a single-particle orbit picture of the plasma ions in the puffatron (a device with rotating plasma), the corresponding ion velocity distribution function is calculated. The spread in the ion Larmor velocity due to the initial break-down phase is taken into account assuming a parabolic distribution for this spread. The calculated ion velocity distribution function is integrated along a chord in order to make it possible to compare the calculations with suitable measurements along a chord of the ion velocity spectrum.

PLASMA PRODUCTION

50862 (KFTI—77-39, pp 4-10) **Integral model of a pulse coaxial plasma gun.** Belikov, A.G.; Goncharenko, V.P.; Goncharenko, D.K.; Derepovskii, N.T. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

The integral model of a pulse coaxial plasma gun is described. The main characteristic feature of the model is registration of the non-uniform working gas distribution and the shifting of the place of the primary accelerator breakdown. It is shown that the model describes well the dependence of the profile of the discharge current curve on the accelerator gas inventory as well as the velocity of the current front and the dynamics of the energy transfer from the accelerator battery into plasma. From the analysis of the results of the numerical calculations it is clear that to achieve optimal results it is necessary to coordinate the gas accelerator inventory in every specific case with its electrotechnical parameters.

PLASMA INSTABILITIES

50863 (CONF-7709167—, pp 49-54) **High beta tokamak instabilities.** Bateman, G. (Oak Ridge National Lab., TN). Sep 1977.

From Finite beta theory workshop; Verenna, Italy (Sep 1977).

Theoretical predictions using the ideal MHD model indicable that large-scale ballooning modes should appear when the average beta is raised about 1 to 2% in present-day tokamak geometries or 5 to 10% in more optimized geometries. The onset of instability is predicted to be sudden and the behavior of ballooning modes to be strikingly different from the saw-tooth and Mirnov oscillations experimentally observed at low beta. Conditions close to the predicted onset were achieved in ORMAK with no noticeable change in plasma behavior. Experiments are planned for the ISX tokamak to test the beta limit. 15 references, 3 figures.

50864 (IAE—2860) **Stability of internal helical mode in a tokamak with a high-pressure plasma.** Krymskii, A.M.; Mikha lovskii, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 12p. (In Russian). U 02/MF A01.

The internal helical mode stability in a circular-section axisymmetric tokamak containing high-pressure plasma is investigated. The effect of magnetic well deepening due to magnetic axis curvature and ballon effects which are typical only of a nonuniform

longitudinal magnetic field on the internal helical mode stability is considered.It is shown that this mode is actually a hybride of two-flute and current- instabilities. It has been found that internal helical mode (m=1) instability can disappear when βsub(I)>1 . Stabilization is due to magnetic well deepening in a manner similar to the case of small-scale flute instabilities.

50865 (IAE—2878) **High-pressure plasma stability in the axial region of toroidal traps.** Aburdzhaniya, Kh.D.; Mikhailovskii, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 15p. (In Russian). U 02/MF A01.

The local hydromagnetic stability of the near-axis region of a high-pressure plasma confined in toroidal traps of near-circular section with an arbitrary shape of the magnetic axis was investigated. For this purpose equations for the triangularity of magnetic surfaces, and also for the shift of the magnetic surfaces with an accuracy to the fifth order in pressure were obtained. The criterion for the local stability of the near-axis plasma region was derived and then used to investigate the stability of a tokamak with a modulated curvature of the magnetic axis. It is shown that at some resonance values of the safety factor the presence of the second harmonic of the Fourier expansion of the curvature destabilizes the high-pressure plasma in a tokamak.

50866 (IAE—2953) **Theory of ballooning modes in tokamak devices with high β.** Mikhailovskii, A.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. 14p. (In Russian). U 02/MF A01.

General problems of the theory of small-scale MHD instabilities of a tokamak with large β are considered. Two important problems have been solved i.e., that connected with the evaluation of relative importance of ballooning modes and the Seidem perturbations, and the second one touching the substance of the Mersieur criterion at large β. At rather general suppositions it is shown that the Mersieur stability criterion is a sufficient criterion of the stability of ballooning modes. It is stated that the Mersieur criterion is not fulfilled at $\beta(>=)a/Rq^2$, where a, R are the small and large tokamak radii, q is the reserve coefficient. The correspondence of this result and those of computer experiments also giving evidence on instability at $\beta(>$ approximately) a/Rq^2 is considered.

50867 (IAE—3025) **"Frequency capture" of the plasma helical instability in a tokamak.** Ivanov, N.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1978. 9p. (In Russian). U 02/MF A01.

Presented are considerations of the possible plasma helical instability "frequency capture" mechanism in a tokamak by the external variable magnetic field. Frequency dependences of the "capture" threshold and of phases and amplitudes of "captured" mode as well are calculated for the forced wave model with the fixed amplitude. Calculation results are compared with the experimental data, obtained at ATC tokamak.

50868 (PPPL—1561) **Tearing modes in a plasma with magnetic braiding.** Kaw, P.K.; Valeo, E.J.; Rutherford, P.H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1979. Contract EY-76-C-02-3073. 20p. P 02/MF A01.

We examine certain linear and nonlinear properties of macroscopic tearing modes driven by anomalous electron viscosity effects associated with magnetic braiding. It is shown that strong linear growth of m = 1, 2 tearing modes (respectively proportional to μ/sup 1/5/ and μ/sup 1/3/) can occur for rather modest values of μ. In the nonlinear phase, the island width grows in time as t/sup 1/3/. Some speculations regarding the disruptive instability in Tokamaks are also investigated.

50869 (PPPL—1565) **Ion acoustic double layers.** Sato, T.; Okuda, H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1979. Contract EY-76-C-02-3073. 16p. P 02/MF A01.

It is found that, by means of numerical simulations, an ion acoustic instability (v/sub d/ < v/sub te/) results in the formation of double layers in a sufficiently long system. Anomalous resistivity generated by the ion acoustic instability causes the buildup of a dc potential which in turn accelerates electrons further to enhance the original instability leading to the formation of double layers. A necessary condition required for generating a double layer is given.

50870 (RISO-M—2116) **Particle simulation code for analysis of nonlinear electron oscillations in a plasma waveguide.** Turikov, V.A. (Risoe National Lab., Roskilde (Denmark)). Aug 1978. 26p. U 03/MF A01.

A description is given of a computer code for simulation of electron oscillations in a magnetized plasma in a cylindrical waveguide. The one-dimensional particle-in-cell method with the reverse linear interpolation of charge density is used. The program has options for treating nonlinear processes in a plasma with periodical and reflecting boundary conditions. For periodical conditions, Poisson's equation is solved by means of the Fourier method. For reflecting conditions, the double recursive procedure is used. The values of the potential derivatives at the space grid points are calculated by means of the parabolic interpolation. The main purpose of the program is to investigate nonlinear phenomena in a plasma column after applying a short localized impulse of an external electric field.

50871 (TRITA-PFU—77-07) **Stability of localized drift modes in the boundary layers of high density gas insulated plasmas.** Ohlsson, D. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Nov 1977. 36p. U 03/MF A01.

Gas blanket systems are of interest for mainly two reasons. First, plasma wall interaction effects are expected to be considerably reduced due to the presence of the surrounding neutral gas. Consequently the impurity radiation due to impurities originating from plasma wall interaction processes is probably eliminated to a large extent. Second, the fueling of a future thermonuclear reactor can take place in a natural way in gas blanket systems in the sense that neutrals can diffuse inwards at a suitable rate to replace burnt fuel under certain conditions. In this analysis we consider certain stability aspects of plasmas surrounded by neutral gas. In particular we consider the stability of localized collisional drift modes, in the cool partially ionized boundary regions. In these regions large pressure gradients are expected due to plasma neutral gas interaction effects. It is concluded that stability is possible within certain parameter ranges due to the presence of several stabilizing effects associated with finite Larmor radius and viscosity effects and coupling between dissipative effects directly or indirectly connected with plasma neutral gas interaction processes.

50872 (TRITA-PFU—77-09) **Stability properties of cold blanket systems for current driven modes.** Ohlsson, D. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Dec 1977. 36p. U 03/MF A01.

The stability problem of the boundary regions of cold blanket systems with induced currents parallel to the lines of force is formulated. Particular interest is focused on two types of modes: first electrostatic modes driven by the combined effects of a transverse resistivity gradient due to a spatially non-uniform electron temperature and a longitudinal current, second electromagnetic kink like modes driven by the torque arising from a transverse current density gradient and magnetic field perturbations. It is found that the combination of various dissipative and neutral gas effects introduces strong stabilizing effects within specific parameter ranges. For particular steady-state models investigated it is shown that these effects become of importance in laboratory plasmas at relatively high densities, low temperatures and moderate magnetic field strengths. Stability diagrams based on specific steady-state cold plasma blanket models will be presented.

50873 (TRITA-PFU—78-04) **Stability aspects of plasmas penetrated by neutral gas with respect to velocity driven modes.** Ohlsson, D. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Aug 1978. 40p. U 04/MF A01.

A study of the stability properties of dense partially ionized plasmas immersed in strong magnetic fields with respect to velocity driven modes are presented. First we consider modes driven by mass motion perpendicular to the lines of force and the unperturbed density and temperature gradients. The presence of a third fluid, neutral gas, gives under certain conditions rise to unstable modes. This type of instability arises independently or whether the applied electric field transverse to the lines of force, driving the mass motion, being parallel or antiparallel to the unperturbed density and temperature gradient. The presence of neutral gas also corresponds to stabilizing effects which, in certain parameter regions, result in a quenching of this instability. It is shown that modes driven by velocity shear perpendicular to the lines of force are effectively stabilized by viscous and resistive effects. These effects are in certain parameter ranges strongly enhanced on account of plasma-neutral gas interaction effects. In collisionless plasmas, modes driven by velocity shear parallel to the lines of force are stabilized by compressibility effects parallel to the magnetic field and by finite Larmor radius effects.

50874 (TRITA-PFU—78-07) **Stability of boundary layers in gas mantle systems.** Ohlsson, D. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Oct 1978. 14p. U 02/MF A01.

In this thesis a systematic investigation of the stability properties of the partially ionized boundary regions of gas mantle systems for a large class of dissipative magneto-hydrodynamic modes is presented. In the partially ionized boundary regions of gas mantle systems several strong stabilizing mechanisms arise due to coupling between various dissipative effects in certain parameter regions. The presence of neutral gas strongly enhances the stabilizing effects in a dual fashion. First in an indirect way by cooling the edge region and second in a direct way by enhancing viscous and heat conduction

effects. It has, however, to be pointed out that exceptions from this general picture may be found. The stabilizing influence of neutral gas on a large class of electrostatic as well as electromagnetic modes in the boundary regions of gas blanket systems is contrary to what has been found in low density weakly ionized plasmas. In these latter cases presence of neutral gas has even been found to be responsible for the onset of entirely new classes of instabilities. Thus there is no universal stabilizing or destabilizing effect associated with plasma-neutral gas interaction effects.

50875 Nonlinear saturation and recurrence of the two-plasmon decay instability. Langdon, A.B.; Lasinski, B.F.; Kruer, W.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev. Lett.;* **43**: No. 2, 133-136(9 Jul 1979).

Two-dimensional computer simulations show that short-wavelength ion fluctuations and density-profile steepening are dominant factors in the saturation of the 2ω/sub p/e instability. The long-term evolution of this instability is described and the implications of this complex saturation process for absorption and harmonic emission are discussed.

50876 Experimental study of axisymmetric instability of inverse-dee and square tokamak equilibria. Lipschultz, B.; Prager, S.C.; Osborne, T.H.; Sprott, J.C.; Phillips, M. (University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev. Lett.;* **43**: No. 1, 36-39(2 Jul 1979).

Inverse-dee— and square—shaped equilibria are observed by experimentally mapping the magnetic-flux plot as a function of time in a tokamak with a 4-null poloidal divertor. Inverse-dee equilibria are observed to be unstable to the vertical magnetohydrodynamic axisymmetric instability on a time scale $\sim$ 1000 poloidal Alfven times. Square equilibria are stable on the time scale available for observation. Instability growth is apparently slowed by field-shaping hoop and wall passive stabilization.

50877 Observation of an ion-beam-driven instability in a magnetized plasma. Gold, S.H.; DeSilva, A.W. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **42**: No. 26, 1750-1753(25 Jun 1979).

We have observed, by CO_2-laser-light scattering, large-amplitude electron-density fluctuations with kλ/sub D/ $\sim$ 0.1 and a narrow angular spread in k about the direction normal to a transient shocklike distance. This shock propagates radially inwards in a cylindrical plasma [n/sub e/ = (1 - 6) x 10^{13} cm^{-3}, T/sub e/ $<$ or $\approx$ 1 eV] having an axial magnetic bias field of 170 G. The observed fluctuations are seen in a narrow region in front of the shock where a stream of reflected ions passes through the background plasma, and are thought to be driven by this stream.

PLASMA WAVE PHENOMENA

50878 (KFKI—1978-21) **Comments on the dispersion equation of a turbulent plasma - an inhomogeneous, magnetoactive case.** Ag, A. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). Mar 1978. 25p. U 03/MF A01.

A weakly turbulent, magnetoactive plasma is considered in an inhomogeneous case with anisotropic temperature distribution. The dispersion relation is established following a method developed by Tsytovich and Nekrasov. The correction coefficients are calculated in the three principal scaling modes: (1) the turbulent frequencies predominate, (2) the cyclotronic velocities of the macroinstabilities predominate, (3) the turbulent frequencies are lower.

50879 (KFTI—77-39, pp 40-41) **Shock wave formation in high density plasmoids interacting with magnetic barrier.** Kalmykov, A.A.; Trubchaninov, S.A. 1977. (In Russian).

In Plasma physics and the controlled thermonuclear fusion problems.

The interaction of dense plasma bunches with the axial-symmetric magnetic mirror field is studied. The plasma bunches with the density of 10^{14}-10^{15} cm^{-3} and the rate of (5-8)x10^6 cm/s were injected from a coaxial plasma source in the magnetic field of a single coil with intensity of 2500 Oe. By electric and magnetic probes the radial distributions of plasma and azimuthal induced currents densities in different cross-sections of the magnetic mirror were measured. With this interaction a radial shock wave is formed which brings about axial thermalization of directed energy. This interaction mechanism can take place in plasma confining in open magnetic traps as well as in astrophysical processes.

50880 (KIYI—77-16) **Nonlinear wave amplification in electpon beam-plasma system.** Pavlenko, V.P. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1977. 20p. (In Russian). U 03/MF A01.

The nonlinear amplification of explosive type waves is investigated in plasma electron beam system provided that the wave number values of the interacting high frequency waves are in resonance region. For a weak wave coupling the amplification is shown to be enhanced as compared with the case of a usual explosive amplification occuring in nonresonance region. The obtained self-similar solutions demonstrate that the wave amplitudes grow more steeply and the characteristices amplification length decreases essentially.

50881 (RISO—380) **Computer simulation of the formation of Langmuir solitons and holes in a cylindrical magnetized plasma column.** Turikov, V.A. (Risoe National Lab., Roskilde (Denmark)). Jun 1978. 28p. U 03/MF A01.

Nonlinear plasma oscillations in a cylindrical plasma resulting from a short localized external excitation are examined by means of a particle-in-cell simulation scheme. Computer calculations are performed for describing the experimental results obtained in a single-ended Q-machine plasma in a cylindrical waveguide. It is assumed that there is a strong magnetic field in the direction of the column axis. When the amplitude of the excitation potential is close to the kinetic energy of electrons having a phase velocity of the electron plasma wave, the formation is observed of solitons and holes in phase space. After formation, the solitons and holes move with constant velocities. The velocities of solitons are close to the wave-phase velocity, while holes move with smaller velocities. When the external potential amplitude is increased, there is a tendency that the number of holes grows. The potential amplitude of the self-consistent field in the soliton region damps in time with increasing soliton width. The potential profile of the hole does not change after its formation.

50882 (RISO-M—2120) **Wave propagation in an ion beam plasma system.** Jensen, T.D.; Michelsen, P.; Rasmussen, J.J. (Risoe National Lab., Roskilde (Denmark)). Aug 1978. 24p. U 03/MF A01.

The spatial evolution of a velocity - or density - modulated ion beam is calculated for stable and unstable ion beam plasma systems, using the linearized Vlasov - Poisson equations. The propagation properties are found to be strongly dependent on the form of modulation. In the case of velocity modulation, the perturbation grows initially and then shows a periodic change of amplitude along the beam, while in the case of a density modulation only an instability causes growth. The findings are in agreement with experimental results obtained by Sato et al. (1977).

50883 Stimulated Thomson scattering. Spencer, R.L.; Lawler, J.E.; Anderson, L.W. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Phys. Rev., A;* **20**: No. 1, 304-315(Jul 1979).

The theory of stimulated Thomson scattering is investigated both quantum mechanically and classically. In the interaction of a collisionless plasma with two electromagnetic waves, both with frequencies well above the plasma frequency, energy is transferred from the high-frequency wave to the low-frequency wave via stimulated Thomson scattering. This process is mediated by the nonlinear interaction of the plasma electrons with a beat wave at the difference frequency between the two waves; this beat frequency must be well above the plasma frequency. The gain coefficient for stimulated Thomson scattering is calculated both quantum mechanically and classically, and identical results are obtained. The classical calculation also yields the first nonlinear term in the index of refraction due to stimulated Thomson scattering, as well as the details of the saturation of the gain and the index of refraction. The authors present explicit formulas for the gain coefficient and the index of refraction, in the unsaturated limit, for both very cold and very hot plasmas. The calculations indicate that it should be possible to detect stimulated Thomson scattering experimentally by means of polarization enhancement. In an appendix, the theory of stimulated Thomson scattering is used to treat the free-electron amplifier.

50884 Non-linear plasma kinetics. Solitons, cavitons and spikons. Tsytovich, V.N. (AN SSSR, Moscow. Fizicheskij Inst.). pp 221-253 of Theoretical and computational plasma physics. Vienna; IAEA (1978).

From College in theoretical and computational plasma physics; Trieste, Italy (22 Mar 1977).

This paper deals with non-linear plasma kinetics; i.e. the kinetic description of those non-linear self-consistent entities (solitons, cavitons, spikons, etc.) formed into a plasma.

FUSION POWER PLANT TECHNOLOGY

50885 (IAE—2772) **Design and physical principles of the T-12 ring tokamak with two axial symmetrical divertors.** Bortnikov, A.V.; Brevnov, N.N.; Gerasimov, S.N.; Zhokin, A.M.; Kazachkov, A.A.; Mazurov, V.L.; Sokolov, N.I.; Shchurov, O.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 28p. (In Russian). U 03/MF A01.

Investigated are the problems, connected with elaboration of methods for diminishing impurities entering plasma and utilization of axial symmetrical divertor for this aim. In particular, considered is the possibility of providing conditions for external (beyond separatrix surface) extraction of magnetic field lines in the divertor during

all stages of discharge current flow. Studied are the plasma filament stability in relation to vertical displacement and the influence of physical processes in the divertor layer on plasma filament parameters. Physical parameters of the plasma filament are determined. Considered is the problem of providing operating conditions for an "ideal" divertor, in which full absorption of entering plasma flux takes place. The investigation in the plasma filament of oblonged cross section with the following plasma parameters: n approximately $5x10^{15}$ cm^{-13}, T approximately 500 eV, tausub(E)(>approximately)1ms, βsub(J) approximately 1 were carried out on a ring tokamak with two axial symmetrical divertors, the construction and physical principles of which are presented.

50886 (NRCN—460) **Source driven breeding thermal power reactors. Part I. Using D-T fusion neutron sources.** Greenspan, E.; Schneider, A.; Misulovin, A.; Gilai, D.; Levin, P. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Mar 1978. 46p. U 04/MF A01.

Improvements in the performance of fission power reactors made possible by designing them subcritical driven by D-T neutron sources are investigated. Light-water thermal systems are found to be most promising, neutronically and energetically, for the source driven mode of operation. The range of performance characteristics expected from breeding Light Water Hybrid Reactors (LWHR) is defined. Several promising types of LWHR blankets are identified. Options opened for the nuclear energy strategy by four types of the LWHRs are examined, and the potential contribution of these LWHRs to the nuclear energy economy are discussed. The power systems based on these LWHRs are found to enable a high utilization of the energy content of the uranium resources in all forms available - including depleted uranium and spent fuel from LWRs, while being free from the need for uranium enrichment and plutonium separation capabilities.

50887 (NRCN—461) **Source driven breeding thermal power reactors. Part II. Using lithium-free neutron sources.** Greenspan, E. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Mar 1978. 43p. U 04/MF A01.

The feasibility of fusion devices operating in the semi-catalyzed deuterium (SCD) mode and of high energy proton accelerators to provide the neutron sources for driving subcritical breeding light water power reactors is assessed. The assessment is done by studying the energy balance of the resulting source driven light water reactors (SDLWR) and comparing it with the energy balance of the reference light water hybrid reactors (LWHR) driven by a D-T neutron source (DT-LWHR). The conditions the non-DT neutron sources should satisfy in order to make the SDLWR viable power reactors are identified. It is found that in order for a SCD-LWHR to have the same overall efficiency as a DT-LWHR, the fusion energy gain of the SCD device should be at least one half that the DT device. The efficienct of ADLWRs using uranium targets is comparable with that of DT-LWHRs having a fusion energy gain of unity. Advantages and disadvantages of the DT-LWHR, SCD-LWHR and ADLWR are discussed.

50888 (ER—77-2, pp 27-29) **Nuclear fusion.** Redhead, P.A. (National Research Council of Canada, Ottawa, Ontario). [nd].

In Nuclear option for Canada. The renewable energy resources.

A little background on nuclear fusion is given, along with the rationale for the small Canadian research program in this area.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 50305

50889 (JAERI-M—7610) **Recent results in the DIVA experiment.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1978. 72p. U 05/MF A01.

Divertor effects have been studied over a wide range of plasma parameters: electron temperature T sub(eo) = 200 - 700 eV, ion temperature T sub(io) = 60 - 300 eV and density n sub(eo) = (1.5 - 8.0) x 10^{13} cm^{-3} in the main plasma, and T sub(es) = 20 - 100 eV, T sub(is) = 20 - 60 eV and n sub(es) = (1.5 - 5.0) x 10^{12} cm^{-3} in the scrape-off layer plasma. The following results are obtained. 1) The divertor reduces plasma-wall interactions near the main plasma by guiding loss plasma into the divertor chamber. A maximum divertor efficiency is 35% for particle flux and 75% for heat flux. 2) The scrape-off layer plasma shields impurity influx, guides ionized impurities into the divertor, and reduces influx of injected impurities into the main plasma by a factor of 2 - 4. Shielding efficiency is higher for aluminum than for carbon. Shielding effect is also observed in a conventional discharge. 3) The divertor reduces radiation loss by a factor of 2 - 4 and hence increases the energy-confinement time by a factor of 2.5. 4) The divertor does not significantly affect particle-confinement time, ion temperature and heat diffusion coefficient. 5) The radiation loss due to pseudo continuum mainly from gold ions is comparable to that due to oxygen lines. Impurity confinement time is comparable to the average particle-confinement time. 6) The particle flow velocity is a few times less than the sound velocity, the heat transmission rate is consistent with a sheath model, and the particle diffusion coefficient in the scrape-off layer is about ten times less than the Bohm diffusion coefficient. Scaling for electron temperature is obtained. 7) Ion sputtering, arcing and evaporation are identified. The ion sputtering by impurity ions is the dominant process of metallic impurity release from a limiter or a neutralizer plate in a stable discharge.

50890 (TRITA-PFU—77-08) **Conditions of existence of cold-blanket systems.** Lehnert, B. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Dec 1977. 45p. U 04/MF A01.

An extended analysis of the partially ionized boundary layer of a magnetized plasma has been performed, leading to the following results: (i) In a first approximation the ion density at the inner "edge" of the layer becomes related to the wall-near neutral gas density, in a way being independent of the spatial distribution of the ionization rate. (ii) The particle and momentum balance equations, and the associated impermeability condition of the plasma with respect to neutral gas penetration, are not sufficient to specify a cold-blanket state, but have to be combined with considerations of the heat blance. This leads to lower and upper power input limits, thus defining conditions for the existence of a cold-blanket state. At decreasing beta values , or increasing radiation losses, there are situations where such a state cannot exist at all. (iii) It should become possible to fulfill the cold-blanket conditions in full-scale reactors as well as in certain model experiments. Probably these conditions can also be satisfied in large tokamaks like JET, and by fast gas injection in devices such as Alcator, but not in medium-size tokamaks being operated at moderately high ion densities. (iv) A strong "boundary layer stabilization" mechanism due to the joint viscosity-resistivity-pressure effects is available under cold-blanket conditions.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 50868, 50917

50891 (CONF-790738—2) **Transient 3-D eddy current in multiple conductors.** Yeh, H.T. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 11p. P 02/MF A01.

From Joint INTERMAG-MMM conference; New York, NY, USA (17 Jul 1979).

A computer program has been implemented to model the transient eddy current in multiple thin conductors. This program allows for holes and multiple materials and has symmetry options built in. For cases with known solutions, the program has been checked for the eddy current induced in a cross, a plate with holes, a bent plate, an aluminium plate coil case, a plate with two materials, multiple plates, etc.

50892 (IAE—2790) **Structure of magnetic field dist ances during breakaway instability in the T-6 tokamak.** Merezhkin, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 29p. (In Russian). U 03/MF A01.

The poloidal field structure and disturbance dynamics under developing the thyrring instability using "Tokamak-6" are considered. The experiment consisted in studying well-reproducible discharge conditions with a plasma current of 50 kA, a longitudinal field of 5 kOe, and parameter q approximately 2.5. Under these conditions at the steady discharge stage plasma has been characterized by the following parameters: anti nsub(e) approximately $5.5x10^{12}$ cm^{-3}; Tsub(e) approximately 280 eV; Tsub(i) approximately 140 eV; βsub(tau) approximately 0.25. The behavior of the symmetric and dipole field components and helical disturbance features on minor and major instabilities are analyzed. The governing role of the helical disturbances with harmonics m=2 at the initial stage of the instability development is shown. The symmetric and helical components of the poloidal field disturbances at the front of their build up have been found to be correlated. Data on helical disturbance increments, scale and structure, relationships between the symmetric and helical field components and typical energy loss by plasma are presented.

50893 (LA—7862-MS) **Experiments on the ZT-S reversed-field pinch, August—December 1978.** Jacobson, A.R. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 42p. P 03/MF A01.

During the latter half of 1978 the ZT-S reversed-field pinch was used to explore the utility of pitch-programming techniques in setting up stable diffuse pinch profiles. Several experimental observations relating to this goal are presented.

50894 (UCRL—15043) **Structural stability analysis for the Mirror Fusion Test Facility (MFTF) jacket assembly.** Smith, G.W. (General Dynamics/Convair, San Diego, CA (USA)). May 1979.

Contract W-7405-ENG-48. 55p. (GDC-LLL—79-003). P 04/MF A01.

A structural analysis was performed for the unsupported MFTF jacket assembly. The STAGS (Structural Analysis of General Shells) computer code was used to obtain linear and bifurcation buckling data for a one-quarter model considering all possible combinations of boundary conditions. The primary results are summarized.

POWER SUPPLIES, ENERGY STORAGE

50895 (SAND—79-0748C) **Compton scattering of photons from electrons in magnetically insulated transmission lines.** Brower, K.L.; VanDevender, J.P. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 4p. (CONF-790622—3). P 02/MF A01.

From Pulsed power conference; Lubbock, TX, USA (12 Jun 1979).

Self-magnetically insulated transmission lines are used for power transport between the vacuum insulator and the diode in high current particle accelerators. Since the efficiency of the power transport depends on the details of the initial line geometry, i.e., the injector, the dependence of the electron canonical momentum distribution on the injector geometry should reveal the loss mechanism. We propose to study that dependence experimentally through a Compton scattering diagnostic. The spectrum of scattered light reveals the electron velocity distribution perpendicular to the direction of flow. The design of the diagnostic is in progress. Our preliminary analysis is based on the conservation of energy and canonical momentum for a single electron in the anti E and anti B fields determined from 2-D calculations. For the Mite accelerator with power flow along Z, the normalized canonical momentum, μ, is in the range - 0.7 $< \mu \leqq$ 0. For anti k/sub i/ parallel to circumflex Y, and anti k/sub s/ circumflex X, our analysis indicates that the scattered photons have 1.1 eV $\leqq$ h nu/sub s/ $<$ 5.6 eV for ruby laser scattering and can be detected with PM tubes.

50896 (SAND—79-1118C) **Magnetic flux compression by expanding plasma armatures.** Wright, T.P.; Baker, L.; Cowan, M.; Freeman, J.R. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 14p. (CONF-790540—10). P 02/MF A01.

From 2. international conference on megagauss magnetic field generation and related topics; Washington, DC, USA (29 May 1979).

A one-dimensional magnetohydrodynamic computer code has been developed to study magnetic flux compression using explosively driven plasma armatures in cylindrically symmetric systems. This work supports a program to develop a compact, non-destructive, repetitive pulse power generator capable of multimegajoule outputs with pulse widths of about 10^{-5} sec. Details of the code construction and results of some calculations including the cynamics of the explosive detonation are presented.

COOLING SYSTEMS

50897 (BNL—25811) **Thermo-fluid mechanics of liquid or gas-cooled tubular first walls.** Fillo, J.A.; Powell, J.R. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 11p. (CONF-790802—9). P 02/MF A01.

From International conference on structural mechanics in reactor technology; Berlin, F.R. Germany (13 Aug 1979).

An analysis for hydrodynamically and thermally, fully developed heat transfer in a circular tube coupled with heat conduction in the tube wall is presented. Anisotropy of turbulent energy transport has been taken into account employing theoretical results for eddy diffusivity in the various directions. The energy equations for the fluid and solid body are solved simultaneously and are subject to continuity in heat flux and temperature at the interface. Solutions of the equations are found by separation of variables. Indicative of the analysis is that neglecting radial conduction but allowing circumferential conduction results in underestimating the wall temperature for relatively thin-wall structures and also the fluid temerature. In addition, a comparison of the dimensionless tube wall temperatue equation derived from the coupled analysis with that based on a constant heat transfer coefficient indicates that the constant heat transfer analysis can be made identical with the present case by renormalizing the heat transfer coefficient. The analysis provides the designer with a simple set of analytical design equations for the coupling of solid and fluid temperature distributions for obtaining the Nusselt numbers.

50898 (CLM-R—184) **Design of the segment structure and coolant ducts for a fusion reactor blanket and shield.** Briaris, D.A.; Stanbridge, J.R. (UKAEA, Abingdon. Culham Lab.). May 1978. 17p. U 03/MF A01.

An outline design and analysis of a support structure for the replaceable first wall of a helium cooled fusion reactor blanket has been undertaken. The proposed structure supports all the segment gravitational loads with maximum deflections limited to $<$ 10 mm, and is itself supported off the outer shield by a simple vee-in-groove arrangement. It is a feature of the design that the coaxial coolant pipes and the segment structure operate at the same temperature, making it possible for them to be integrated, thereby avoiding the necessity for pipe bellows. The requirements of cooling the inner arm of the structure and increasing the major radius of the torus by approximately = 0.5 m, have been identified as problems associated with the 'horseshoe' shaped structure applicable to the reactor with divertor. For a ring structure, i.e. reactor without divertor, these problems do not arise.

50899 (NIIEFA-A—0375) **Effect of geometry of cooled boundaries of structural elements of electrophysical devices under cyclic thermal loading.** Divavin, V.A.; Guseva, M.A.; Bolotova, E.D. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1978. 12p. (In Russian). U 02/MF A01.

A non-stationary thermal field of a surface element with built-in cooling channels under one-side cyclic heat flow loading is considered. The cooling channels are in the form of tubes built in the thin-walled construction of a diameter considerably greater than the wall thickness. In one-dimensional approximation an analytical solution is obtained for boundary conditions of the third type (BC), as well as for modified BC when the cooling medium temperature is a linear function of time (sawtoothed). A comparison of the one-dimensional problem results with those of the numerical two-dimensional problem for an initial profile obtained by net methods is amade for the vacuum chamber of the T-20 demonstration thermonuclear tokamak-reactor. An accumulative influence of the lower parts of cooling channels has been shown. The conclusion is made that the one-dimensional approximation in the calculation of the profile gives the acceptable results only for the cases when the mass surface of the developed cooling zones are small in comparison with the bulkhead body. Otherwise, and especially at high temperatures the necessity of transfer to the two-dimensional solution with provision for emission appears.

HEATING AND FUELING SYSTEMS

50900 (IAE—2898) **IBM-5 ion source without an external magnetic field.** Kulygin, V.M.; Panasenkov, A.A.; Semashko, N.N.; Chukhin, I.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1977. 17p. (In Russian). U 02/MF A01.

In controlled fusion research one of the chief problems is the injection of power beams of fast hydrogen atoms into magnetic traps. The development of effective injectors depends largely on the progress in the design of high-current ion source modules. In this relation the paper gives a description of a specific large-area plasma emitter by means of a low-voltage diffusion discharge in a discharge chamber with a distributed cathode without an external magnetic field. Ion selection and beam shaping are effected by means of a three-electrode multi-slit ion-optical system. The IBM-5 ion source (nonmagnetic ion module) design is described, which is intended to be used in the T-11 tokamak injector. IBM-5 allows to obtain hydrogen ions with energies of up to 25 keV, current of more than 30 A, and pulse duration of 20 ms. When it will be used in the T-11 tokamak, an atom flux up to 320 kW at particle energy of 20 keV or up to 500 kW at particle energy of 25 keV can be injected into the device.

50901 (UCRL—82762) **Railgun accelerators for launching 0.1-g payloads at velocities greater than 150 km/s.** Hawke, R.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jun 1979. Contract W-7405-ENG-48. 15p. (CONF-790741—1). P 02/MF A01.

From DOE impact fusion workshop; Los Alamos, NM, USA (10 Jul 1979).

The promise of an abundant energy supply has inspired many approaches to controlling thermal nuclear fusion. One approach to initiating fusion is to use a hypervelocity projectile to impact a deuterium—tritium (DT) pellet. For this purpose, magnetic accelerators have been propsed for accelerating macroparticles to velocities greater than 100 km/s. This paper summarizes a portion of a study that assesses the feasibility of accelerating a 0.1-g payload to a velocity of 150 km/s or more. In that study it was concluded that magnetic-gradient and railgun accelerators could achieve the goal. The critical factors that limit the design and operation of railgun accelerators are discussed. These factors are combined with a simulation code to assess potential railgun performance in this regime.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

50902 (PPPL—1548) **Use of yttrium for the recovery of tritium from lithium at low concentrations.** Buxbaum, R.E.; Johnson, E.F. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jun 1979. Contract EY-76-C-02-3073. 28p. P 03/MF A01.

A particularly difficult problem for first generation fusion power reactor systems is the recovery of tritium at very low concentration levels from the reactor blanket when lithium metal is the principal tritium breeding medium. On the basis of recent data

and reasonable extrapolations, we show that it is likely that yttrium metal can be used to extract tritium from lithium at concentrations as low as 10^{-6} atom fraction tritium in lithium under conditions that are practicable for commercial power machines.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 50896

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 50528, 50667, 50895

50903 (GSI-P—5-78(Vol.2), pp 499-519) **Targets for heavy ion fusion.** Clauser, M.J. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978.

In Relativistic heavy ion research. Vol. 2. Proceedings.

This paper describes some of the basic principles of fusion target implosions, using some simple targets designed for irradiation by ion beams. Present estimates are that ion beams with 1-5 MJ, and 100-500 TW will be required to ignite high gain targets.

50904 (GSI-P—5-78(Vol.2), pp 471-478) **Heavy ion fusion overview.** Maschke, A.W. (Brookhaven National Lab., Upton, NY (USA)). Jul 1978.

In Relativistic heavy ion research. Vol. 2. Proceedings.

The article discusses the fundamental properties of inertial confinement fusion and the necessary ignition conditions.

50905 (GSI-P—5-78(Vol.2), pp 479-496) **Synchrotron and linear accelerators for heavy ion fusion.** Teng, L.C. (Fermi National Accelerator Lab., Batavia, IL (USA)). Jul 1978.

In Relativistic heavy ion research. Vol. 2. Proceedings.

To obtain high energy-gain from inertial fusion of deuterium/tritium (DT) pellet of millimeter size the DT fuel must first be compressed to some 10^4 times liquid density and then heated at the center to some 10^8K. The compression and heating can be achieved by enclosing the DT fuel in a spherical ablator shell. The ablator shell when struck and heated symmetrically by a number of beams having high energy-content will ablate radially outward, thereby compressing the fuel through the inward reactive force. The sperical shock wave converging at the center will then ignite the central part. Beams proposed for heating the ablator shell are laser beams, electron beams and recently, heavy ion beams. We will discuss, here, accelerator systems which are capable of producing the required heavy ion beams.

50906 (LA-UR—79-1475) **Helios, a 20 TW CO_2 laser fusion facility.** Ladish, J.S. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 10p. (CONF-790720—2). P 02/MF A01.

From 4. international congress LASER 79 opto-electronics; Munich, F.R. Germany (2 Jul 1979).

Since June 1978 the Los Alamos Scientific Laboratory's Helios CO_2 laser fusion facility has been committed to an experimental target program to investigate the feasibility of laser produced inertial confinement fusion. This system is briefly described, and preliminary experimental results are reported.

50907 (UCRL—81537) **Electrostatics, small particles, and laser fusion targets.** Hendricks, C.D (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Sep 1978. Contract W-7405-ENG-48. 22p. (CONF-7811125—1). P 02/MF A01.

From Institute of electrostatics meeting; Tokyo, Japan (26 Nov 1978).

Portions of document are illegible.

The success of any Inertial Confinement Fusion system for the production of useful power depends critically on the production of suitable targets. This is true whether the arrangement is that proposed by Nuckolls et al. or some other arrangement. The target must have characteristics such as material composition, structure, and surface finish which are tailored to the laser pulse length, energy, peak and average power and pulse shape. To provide useful power on a continuous basis, it is likely that the repetition rate will be 1.0 to 10 per second. Thus, in a 24 hour running period 864,000 targets may be necessary and one must be placed at the focal point of the laser every tenth of a second. For economic operation it is necessary that the targets be produced at costs of less than $1.00 per target.

50908 (UCRL—82793) **Brillouin scatter in a hydrodynamic simulation.** Harte, J.; Estabrook, K.; Bailey, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jun 1979. Contract W-7405-ENG-48. 15p. (CONF-790675—2). P 02/MF A01.

From 3. annual conference on transport processes in laser plasmas; Traverse City, MI, USA (18 Jun 1979).

A numerical method for modeling stimulated Brillouin scatter (SBS) in a hydrodynamic simulation code is discussed. Preliminary results using the model show that scattering is reduced as shorter wavelengths are used and for spherical symmetry that ion heating by SBS is not significant since the ions cool by expansion.

50909 **Neon spectral line broadening as a diagnostic for compressed laser-fusion targets.** Auerbach, J.M.; Bailey, D.S.; Glaros, S.S.; Koppel, L.N.; Pan, Y.L.; Richards, L.M.; Slivinsky, V.W.; Thomson, J.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Appl. Phys.;* **50**: No. 8, 5478-5483(Aug 1979).

Experiments have been conducted on the JANUS laser system to measure fuel density in imploded laser-fusion targets filled with deuterium, tritium, and neon. An x-ray crystal spectrometer was used to record the line emission of the 1s-2p line of the Ne^{+9} ion. Simultaneous measurement of the linewidth and the neutron yield indicated that symmetrically irradiated exploding pusher targets reached fuel densities of approximately 1 g/cm^3.

50910 **Ablative acceleration of laser-irradiated thin-foil targets.** Decoste, R.; Bodner, S.E.; Ripin, B.H.; McLean, E.A.; Obenschain, S.P.; Armstrong, C.M. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev. Lett.;* **42**: No. 25, 1673-1677(18 Jun 1979).

Ablative acceleration of thin-foil targets at low laser irradiance (10^{12}—10^{13}W/cm^2) is studied experimentally and theoretically. Ablative acceleration of foils up to $\sim 10^7$ cm/sec with good hydrodynamic efficiency (20%) has been achieved. These and other results are in good agreement with a simple rocket model.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 50898

50911 (CLM-R—182) **Results of Monte-Carlo studies on backscattering and sputtering from 'pocket' and 'finned' structures.** Brown, K.P. (UKAEA, Abingdon. Culham Lab.). Jan 1978. 12p. U 02/MF A01; Also available from H.M. Stationery Office, price Pound1.00.

A Monte-Carlo computer program which has been developed for studying backscattering and sputtering processes involving high energy particles in complex vacuum structures has been used to show that useful reductions in backscattering and sputtering can be achieved by pocketing or finning the wall surfaces of plasma containment vessels.

50912 (HEDL-TME—79-7) **Interactions of liquid lithium with various atmospheres, concretes, and insulating materials; and filtration of lithium aerosols.** Jeppson, D.W. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1979. Contract EY-76-C-14-2170. 125p. P 06/MF A01.

This report describes the facilities and experiments and presents test results of a program being conducted at the hanford Engineering Development Laboratory (HEDL) in support of the fusion reactor development effort. This experimental program is designed to characterize the interaction of liquid lithium with various atmospheres, concretes, and insulating materials. Lithium-atmosphere reaction tests were conducted in normal humidity air, pure nitrogen, and carbon dioxide. These tests are described and their results, such as maximum temperatures, aerosol generated, and reaction rates measured, are reported. Initial lithium temperatures for these tests ranged between 224°C and 843°C. A lithium-concrete reaction test, using 10 kg of lithium at 327°C, and lithium-insulating materials reaction tests, using a few grams of lithium at 350°C and 600°C, are also described and results are presented. In addition, a lithium-aerosol filter loading test was conducted to determine the mass loading capacity of a commercial high efficiency particulate air (HEPA) filter. The aerosol was characterized, and the loading-capacity-versus-pressure-buildup across the filter is reported.

50913 (NRL-MR—4025) **Generation of a rotating liquid liner by tangential injection.** Burton, R.L.; Turchi, P.J.; Jenkins, D.J.; Lanham, R.E.; Cameron, J.; Cooper, A.L. (Naval Research Lab., Washington, DC (USA)). 25 Jun 1979. Contract EX-76-A-34-1006. 18p. P 02/MF A01.

Efficient compression of low mass-density payloads by the implosion of higher mass-density liquid cylinders or liners, as in the NRL LINUS concept for controlled thermonuclear fusion, requires rotation of the liner material to avoid Rayleigh—Taylor instabilities at the liner-payload interface. Experimentally, such implosions have been demonstrated with liners formed within rotating implosion chambers. The present work uses a scale-model experimental apparatus to investigate the possibility of creating liner rotation by tangential injection of the liquid liner material. Different modes of behavior are obtained depending on the fluid exhaust procedures. Right-circular, cylindrical free surfaces are achieved with axial exhaust of fluid at radii interior to the injection nozzles, for which the liner exhibits a combination of solid-body and free vortex flows in different regions. Measurements allow estimates of power losses to viscous shear, turbulence, etc. A simple model based on open-channel flow is then derived, which is in good agreement with experiment, and is

used to extrapolate results to the scale of a possible LINUS fusion reactor.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 50419

50914 (DOE/TIC—4582-R14) **Technical books and monographs. 1979 catalog.** (Department of Energy, Washington, DC (USA)). 1978. 172p. P 08/MF A01.

This publication is a bibliography of books and monographs sponsored by the U.S. Department of Energy (DOE) and by the earlier organizations that were brought together to form DOE. In general, information for each published book, and for each book in press when known, includes title, author, and author affiliation, publisher and publication date, page count, size of book, price, availability information if the book is not available from the publisher, Library of Congress card number (LC) (with CIP to indicate books that have cataloging information in the publication), International Standard Book Number (ISBN), a brief descriptive statement concerning the book, and (for the more recent books) a list or a description of the contents. The books and monographs are grouped under thirteen subject categories. At the end of each subject category are separate sections listing recently published symposium proceedings and bibliographies that received support from DOE or one of the earlier organizations. Also, at the end of the catalog are described the following DOE publications: Energy Research Abstracts, Energy Abstracts for Policy Analysis, Energy Conservation Update, Fossil Energy Update, Fusion Energy Update, Geothermal Energy Update, Solar Energy Update, and Nuclear Safety.

50915 (K/CSD/TM—28) **UCC-ND computer-aided cost estimating system: an overview.** Van Wie, N.H. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Apr 1979. Contract W-7405-ENG-26. 56p. P 04/MF A01.

An overview of the UCC-ND system for computer-aided cost estimating is provided. The program is generally utilized in the preparation of construction cost estimates for projects costing $25,000,000 or more. The advantages of the system to the manager and the estimator are discussed, and examples of the product are provided. 19 figures, 1 table.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 49475, 50803

50916 (LA—7870-MS) **Block relaxation techniques for finite-element elliptic equations: an example.** Boley, D.L.; Parter, S.V. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 19p. P 02/MF A01.

The Ritz—Galerkin equations for the numerical solution of the two-point boundary-value problem $u'' = f$, $0 \leq x \leq 1$, $u(0) = u(1) = 0$, are considered. Ritz—Galerkin subspaces of hermite cubic splines with equally spaced knots are examined. These equations are then solved via iterative methods. The rate of convergence of these methods is estimated.

50917 (LA-UR—79-1320) **INGEN: a general-purpose mesh generator for finite element codes.** Cook, W.A. (Los Alamos Scientific Lab., NM (USA)). May 1979. Contract W-7405-ENG-36. 23p. (CONF-790811—2). P 02/MF A01.

From 5. international seminar on computational aspects of the finite element method; Berlin, F.R. Germany (20 Aug 1979).

INGEN is a general-purpose mesh generator for two- and three-dimensional finite element codes. The basic parts of the code are surface and three-dimensional region generators that use linear-blending interpolation formulas. These generators are based on an i, j, k index scheme that is used to number nodal points, construct elements, and develop displacement and traction boundary conditions. This code can generate truss elements (2 modal points); plane stress, plane strain, and axisymmetry two-dimensional continuum elements (4 to 8 nodal points); plate elements (4 to 8 nodal points); and three-dimensional continuum elements 8 to 21 nodal points). The traction loads generated are consistent with the element generated. The expansion—contraction option is of special interest. This option makes it possible to change an existing mesh such that some regions are refined and others are made coarser than the original mesh. 9 figures.

50918 (ORNL/CSD—38) **Monte Carlo comparisons of selected clustering procedures.** Bayne, C.K.; Beauchamp, J.J.; Begovich, C.L.; Kane, V.E. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 38p. P 03/MF A01.

Monte Carlo methods were used to estimate the percent misclassification of 13 clustering methods for six types of parameterizations of two bivariate normal populations. The clustering methods were compared by using the probabilities of misclassification and incidence matrices. It was determined that large correlations and differences in population sizes adversely influenced all clustering methods, where differences in the variance structure did not appreciably affect the results. The k-means partitioning method was the overall best method. Considering only agglomerative methods, the sum of squares, variance, furthest neighbor and rank score methods were generally superior to the other non-partitioning methods considered. The overall poorest methods were judged to be nearest neighbor and maximum likelihood. However, as the complexity of the distributions increased, the differences between all of the methods decreased.

50919 (ORNL/CSD/TM—67) **FORTRAN subroutines for bicubic spline interpolation.** Gaffney, P.W. (Oak Ridge National Lab., TN (USA)). Jul 1979. Contract W-7405-ENG-26. 33p. P 03/MF A01.

FORTRAN subroutines for computing a bicubic spline function which interpolates values of a function u on a rectangular grid are presented. 3 figures.

50920 (ORNL/TM—6871) **Influence function and its application to data validation.** Chernick, M.R. (Oak Ridge National Lab., TN (USA)). Aug 1979. Contract W-7405-ENG-26. 21p. P 02/MF A01.

Hampel's influence function has been used by Devlin, Gnanadesikan, and Kettenring to detect bivariate observations which have unusual influence on estimates of correlation. In the validation of energy data systems such observations may sometimes be considered to be outliers. The identification of such outliers may be valuable for the detection of errors in a data base. When data are used in regression equations, those observations which have the greatest effect on the multiple correlation coefficient or the regression coefficients are of interest. The contours of constant influence are derived for the multiple correlation coefficient in the case of regressing two variables on a third. In some problems the analytic form of the influence function may be difficult to derive. In such cases the empiric estimator of the influence function, as proposed by Mallows, may be useful for detecting outliers. For FPC form 4 power plant data, the correlation between generation and consumption is a parameter of interest to users of the data. Estimates of the contours of constant influence were determined and used to detect outliers with respect to bivariate correlation.

50921 (ORO—3443-81) **Direct and inverse error estimates for finite elements with mesh refinements.** Babuska, I.; Kellogg, R.B.; Pitkaeranta, J. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology). Apr 1979. Contract EY-76-S-05-3443. 45p. (BN—907). P 03/MF A01.

The finite element method is used to solve a second-order elliptic boundary-value problem on a polygonal domain. Mesh refinements and weighted Besov spaces are used to obtain optimal error estimates and inverse theorems. 2 figures.

50922 (SAND—79-0586C) **Simply sequential and graceful graphs.** Bange, D.W.; Barkauskas, A.E.; Slater, P.J. (Wisconsin Univ., La Crosse (USA). Dept. of Mathematics; Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 8p. (CONF-790482—1). P 02/MF A01.

From 10. S.E. conference on combinatorics, graph theory and computing; Boca Raton, FL, USA (2 Apr 1979).

The concept of a simply sequential graph is introduced as follows. A graph G with $V(G) \cup E(G) = k$ is called simply sequential if there is a bijection $h: V(G) \cup E(G) \rightarrow [1,2...,k]$ such that for each edge $e = xy$ in $E(G)$ one has $h(e) = h(x) - h(y)$. Several problems concerning graceful and simply sequential graphs are discussed. In particular, it is conjectured that all trees are simply sequential. 5 figures.

50923 (UCRL—82431) **Protocol for buffer space negotiation.** Nessett, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Jun 1979. Contract W-7405-ENG-48. 24p. (CONF-790834—1). P 02/MF A01.

From 4. Berkeley workshop on distributed data management and computer networks; Berkeley, CA, USA (28 Aug 1979).

There are at least two ways to manage the buffer memory of a communications node. On etechnique veiws the buffer as a single resource that is to be reserved and released as a unit for a particular communication transaction. A more common approach treats the node's buffer space as a collection of resources (e.g., bytes, words, packet slots) capable of being allocated among multiple concurrent conversations. To achieve buffer space multiplexing, some sort of negotiation for buffer space must take place between source and sink

nodes before a transaction can commence. Results are presented which indicate that, for an application involving a CSMA broadcast network, buffer space multiplexing offers better performance than buffer reservation. To achieve this improvement, a simple protocol is presented that features flow-control information traveling both from source to sink as well as from sink to source. It is argued that this bidirectionality allows the sink to allocate buffer space among its active communication paths more effectively. 13 figures.

50924 (UCRL—82924) **Optimal reconstruction angles.** Cook, G.O. Jr.; Knight, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1979. Contract W-7405-ENG-48. 23p. (CONF-7906100—1). P 02/MF A01.

From IEEE Computer Society conference; Newport Beach, CA, USA (20 Jun 1979).

The question of optimal projection angles has recently become of interest in the field of reconstruction from projections. Here, studies are concentrated on the n x n pixel space, where literative algorithms such as ART and direct matrix techniques due to Katz are considered. The best angles are determined in a Gauss—Markov statistical sense as well as with respect to a function-theoretical error bound. The possibility of making photon intensity a function of angle is also examined. Finally, the best angles to use in an ART-like algorithm are studied. A certain set of unequally spaced angles was found to be preferred in several contexts. 15 figures, 6 tables.

50925 **Interactive code for solving differential equations using phase integral methods.** White, R.B. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *J. Comput. Phys.;* **31**: No. 3, 409-424(Jun 1979).

The solution of ordinary differential equations by the means of Phase Integral Methods is eminently suited for an interactive computational system with real time graphics. We describe a code devised for this purpose and illustrate its use.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-790549-		(Conference on computerized data - acquisition systems in particle and nuclear physics, Santa Fe, NM, USA, 14-17 May 1979)
3	4:50542	*See* LA-UR-79-1251
4	4:50482	*See* LA-UR-79-1221
10	4:50483	*See* LBL-9152
14	4:50537	*See* LA-UR-79-1504
15	4:50484	*See* LBL-9182
CONF-790571-		(6. national conference on energy and the environment, Pittsburgh, PA, USA, 21-24 May 1979)
3	4:49505	Chicago, IL; Institute of Gas Technology (1979).
CONF-790582-		(NATO advanced study institute, Sogesta, Urbino, Italy, 7-14 May 1979)
1	4:50420	Dep. NTIS, PC A02/MF A01
CONF-790590-		(Aerospace/test measurement symposium, Canoga Park, CA, USA, 6-10 May 1979)
1	4:50529	Dep. NTIS, PC A02/MF A01
CONF-790593-		(26. annual design engineering show and conference, Chicago, IL, USA, 7-10 May 1979)
1	4:50428	*See* HEDL-SA-1733-FP
CONF-790595-		(DOE semi-annual review for photovoltaics, Gatlinburg, TN, USA, 16 May 1979)
1	4:49644	*See* SAND-79-1127C
CONF-7905102-		(Symposium on compatibility of plastics and other materials with explosives, propellants, and pyrotechnics, Albuquerque, NM, USA, 15-17 May 1979)
1	4:50557	*See* MHSMP-79-25
CONF-790602-		(ANS annual meeting, Atlanta, GA, USA, 3-8 Jun 1979)
53	4:50580	Dep. NTIS, PC A02/MF A01
74	4:50020	*See* HEDL-SA-1728-FP
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17	4:50021	*See* HEDL-SA-1766
CONF-790622-		(Pulsed power conference, Lubbock, TX, USA, 12-14 Jun 1979)
3	4:50895	*See* SAND-79-0748C
CONF-790626-		(16. design automation conference, San Diego, CA, USA, 25-27 Jun 1979)
2	4:50634	*See* UR-3490-1557
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1	4:50633	*See* UR-3490-1556
CONF-790631-		(6. OTEC conference, Washington, DC, USA, 19-22 Jun 1979)
6	4:49706	*See* SERI/TP-35-254
9	4:49665	*See* LBL-9053
CONF-790641-		(Rare earth research conference, Fargo, ND, USA, 25-28 Jun 1979)
6	4:50415	*See* BNL-26129
CONF-790642-		(International conference on high energy physics, Geneva, Switzerland, 27 Jun-4 Jul 1979)
1	4:50650	*See* BNL-26380
CONF-790646-		(International colloquium on irradiation for reactor safety programmes, Petten, Netherlands, 25-28 Jun 1979)
6	4:50037	Dep. NTIS, PC A02/MF A01
CONF-790648-		(Neutrino 1979 conference, Bergen, Norway, 18-22 Jun 1979)
4	4:50721	*See* LA-UR-79-1423
CONF-790653-		(Superconductivity in d- and f-band metals, San Diego, CA, USA, 21-23 Jun 1979)
9	4:50342	*See* BNL-26424
10	4:50814	*See* BNL-26441
CONF-790658-		(27. annual conference on mass spectrometry and allied topics, Seattle, WA, USA, 3-8 Jun 1979)
2	4:50408	Dep. NTIS, PC A02/MF A01
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1	4:49844	*See* DOE/NASA/1004-79/16
CONF-790666-		(34. Northwest regional meeting of the American Chemical Society, Richland, WA, USA, 13-15 Jun 1979)
2	4:49538	*See* RHO-SA-112
CONF-790667-		(Solar glazing: 1979 topical conference, Pomona, NJ, USA, 22-23 Jun 1979)
1	4:49775	*See* SERI/TP-31-193
CONF-790670-		(IEEE international symposium on application of ferroelectric, Minneapolis, MN, USA, 13-15 Jun 1979)
4	4:50435	*See* SAND-79-0120C
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1	4:50617	*See* BNL-26259
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2	4:50908	*See* UCRL-82793
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1	4:50251	*See* SERI/TP-35-300
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1	4:50666	*See* LA-UR-79-1524
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1	4:50644	*See* LBL-9374
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1	4:50924	*See* UCRL-82924
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1	4:50398	Dep. NTIS, PC A02/MF A01
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7	4:49579	*See* SAND-79-1324C
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14	4:49577	*See* SAND-79-0447C
18	4:50109	*See* SAND-79-1372C

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3(Rev.1)	4:50321	See UCRL-82614(Rev.1)
4	4:50850	See UCRL-82296
5	4:50652	See LA-UR-79-1992
6	4:50808	See SAND-79-1511C
7	4:50377	See UCRL-82126
8	4:50669	See UCRL-82127
9	4:50667	See LA-UR-79-2040
10	4:50329	See LA-UR-79-2039
11	4:50670	See UCRL-82129
CONF-790711-		(International symposium on underground disposal of radioactive wastes, Otaniemi, Finland, 2-6 Jul 1979)
3	4:49555	Dep. NTIS, PC A02/MF A01
CONF-790720-		(4. international congress LASER 79 opto-electronics, Munich, F.R. Germany, 2-6 Jul 1979)
2	4:50906	See LA-UR-79-1475
CONF-790727-		(IIASA-RSI conference on systems aspects of energy and mineral resources, Laxenburg, Austria, 9-14 Jul 1979)
1	4:50163	Dep. NTIS, PC A02/MF A01
CONF-790728-		(24. annual meeting of the Health Physics Society, Philadelphia, PA, USA, 7-13 Jul 1979)
1	4:50481	Dep. NTIS, PC A02/MF A01
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1	4:49475	Dep. NTIS, PC A02/MF A01
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2	4:50315	Dep. NTIS, PC A02/MF A01
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1	4:49909	Dep. NTIS, PC A02/MF A01
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1	4:49854	Dep. NTIS, PC A02/MF A01
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1	4:50575	Dep. NTIS, PC A03/MF A01
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1	4:50565	See SAND-79-8246
CONF-790741-		(DOE impact fusion workshop, Los Alamos, NM, USA, 10-13 Jul 1979)
1	4:50901	See UCRL-82762
CONF-790802-		(International conference on structural mechanics in reactor technology, Berlin, F.R. Germany, 13-17 Aug 1979)
9	4:50897	See BNL-25811
35	4:49972	See UCRL-82423
CONF-790803-		(14. intersociety energy conversion conference, Boston, MA, USA, 5-10 Aug 1979)
10	4:49662	See GA-A-15340
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1	4:49492	Dep. NTIS, PC A02/MF A01
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2	4:50044	See GEFR-SP-171
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2	4:50917	See LA-UR-79-1320
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12	4:50038	Dep. NTIS, PC A02/MF A01
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2	4:50809	See UCRL-82595
3	4:50811	See UCRL-82598
4	4:50810	See UCRL-82597
5	4:50659	See UCRL-82596
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3	4:49450	Dep. NTIS, PC A05/MF A01
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2	4:50429	See SAND-79-1365C
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2	4:50656	See UCRL-82270
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1	4:50923	See UCRL-82431
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2	4:50722	See BNL-26444
3	4:50642	See LBL-8920
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1	4:50548	See UCRL-83008
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5	4:49832	See LBL-9326
6	4:49831	See LBL-9056
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1	4:49430	See SAND-79-8655
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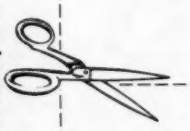

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